electronics today

ISSN 0[illegible]

INTERNATIONAL — NOVEMBER 1980 60p

SPACE INVASION!
First ever DIY project - easily converted to a home computer!

DMMs AT HOME
A market survey

DESIGNING REGULATORS

VERSATILE TEST OSCILLATOR

RADIOACTIVITY EXPLAINED

5 PROJECTS TO BUILD WITH OUR

INSIDE:

WORTH £1!

. . .NEWS. . . .PROJECTS. . . .MICROPROCESSORS. . . .AUDIO. . .

8K ON BOARD MEMORY!
5K RAM 3K ROM or 4K RAM, 4K ROM (link selectable) Kit supplied with 3K RAM 3K ROM System expandable for up to 32K memory

2 KEYBOARDS!
56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code

GRAPHICS!
64 character graphics option — includes transistor symbols! Only £18 20 extra!

MEMORY MAPPED
high resolution VDU circuitry using discrete TTL for extra flexibility Has its own 2K memory to give 32 lines for 64 characters

KANSAS CITY
low error rate tape interface

2 MICROPROCESSORS
Z80 the powerful CPU with 158 instruction, including all 78 of the 8080, controls the MM57109 number cruncher Functions include + — squares, roots, logs, exponentials, trig functions, inverses etc Range 10^{-99} to 9×19^{99} to 8 figures plus 2 exponent digits

EFFICIENT OPERATION
Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC
with extended mathematical capability Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR
resident in EPROM

SINGLE BOARD DESIGN
Even keyboards and power supply circuitry on the superb quality double sided plated through-hole PCB

PSI comp 80
Z80 Based powerful scientific computer design as published in WIRELESS WORLD

COMPLETE KIT
NOW ONLY £225 + VAT

Cabinet size 19.0"x15.7"x3.3"
Television not included in price

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete. Included in the PSICOMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board. 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer. 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

KIT ALSO AVAILABLE AS SEPARATE PACKS
For those customers who wish to spread their purchase or build a personalised system the kit is available as separate packs eg. PCB (16" × 12.5") £43.20. Pair of keyboards £34.80. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautifully finished) £26.50. P.S. Will greatly enhance any other single board computer including OHIO SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

By carefully thought out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable

Mother board:	Fibre glass double sided plated through hole PCB 8.7" x 3.0" set of all components including all brackets fixing parts and ribbon cable with socket to connect to expansion plug	**£39.90**
8K Static RAM board	Fibre glass double sided plated through hole PCB 5.6" x 4.8"	**£12.50**
	Set of components including IC sockets plug and socket but excluding RAMs	**£11.20**
	2114L RAM (16 required)	**£5.00**
	Complete set of board components 16 RAMS	**£89.50**
8K ROM board	Fibre glass double sided plated through hole PCB 5.6" x 4.8"	**£12.40**
	Set of components including IC sockets plug and socket but excluding ROMs	**£10.70**
	2708 ROM (8 required)	**£6.00**
	Complete set of board components 8 ROMs	**£68.50**

AS FEATURED LAST MONTH

★ETI VOCODER★

Panel size 19.0" x 5.25". Depth 12.2".

14 CHANNELS!
NOISE GENERATOR!
LED PPM METERS!
SLEW RATE CONTROL!
2 OSCILLATORS!
VOICED/UNVOICED DETECTOR!

COMPLETE KIT ONLY £195 + VAT

Kit includes FREE foot control and test oscillator!
Like all our kits the ETI VOCODER really is complete — fully finished metal work, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug! Kits also available as separate packs — See our Free Catalogue.

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POWERTRAN ELECTRONICS

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ANDOVER, HANTS SP10 3NM

ANDOVER
(STD 0264) 64455

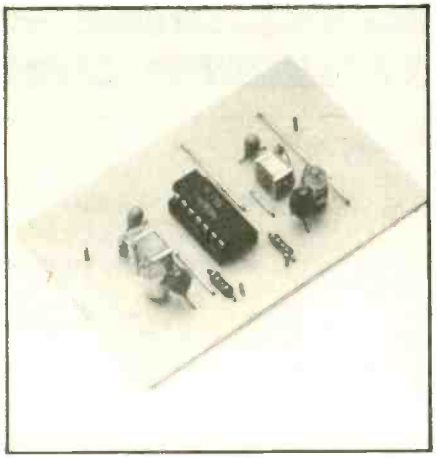
PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until December 31, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.
EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.
U.K. ORDERS. Subject to 15% surcharge for VAT. No charge is made for carriage, or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m.-12 noon, 1-4.30 p.m. Monday-Thursday.

MANY MORE KITS ON PAGE 8

ETI versus the Universe p. 65

Millions of meters (nearly) p. 91



one of the many p39

electronics today

NOVEMBER 1980 VOL.9 NO.11 INTERNATIONAL

FEATURES

PROJECTS

INFORMATION

EDITORIAL AND ADVERTISEMENT OFFICE
145 Charing Cross Road, London WC2H 0EE. Telephone 01-437 1002/3/4/5

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OVERSEAS EDITIONS and their EDITORS: AUSTRALIA - Roger Harrison; CANADA - Halvor Moorshead; GERMANY - Udo Wittig; HOLLAND - Anton Kriegsman

ABC Member of the Audit Bureau of Circulation

MODMAGS LTD

PUBLISHED BY Modmags Ltd., 145 Charing Cross Road, WC2
DISTRIBUTED BY Argus Distribution Ltd. (British Isles) 12-18 Paul Street, London; Gordon & Gotch Ltd. (Overseas)
PRINTED BY QB Limited, Colchester

Electronics Today is normally published on the first Friday in the month preceding cover date.

Subscription Rates UK £10 including postage. Airmail and other rates upon application to ETI Subscriptions Service, PO Box 35, Bridge Street, Hemel Hempstead, Herts.

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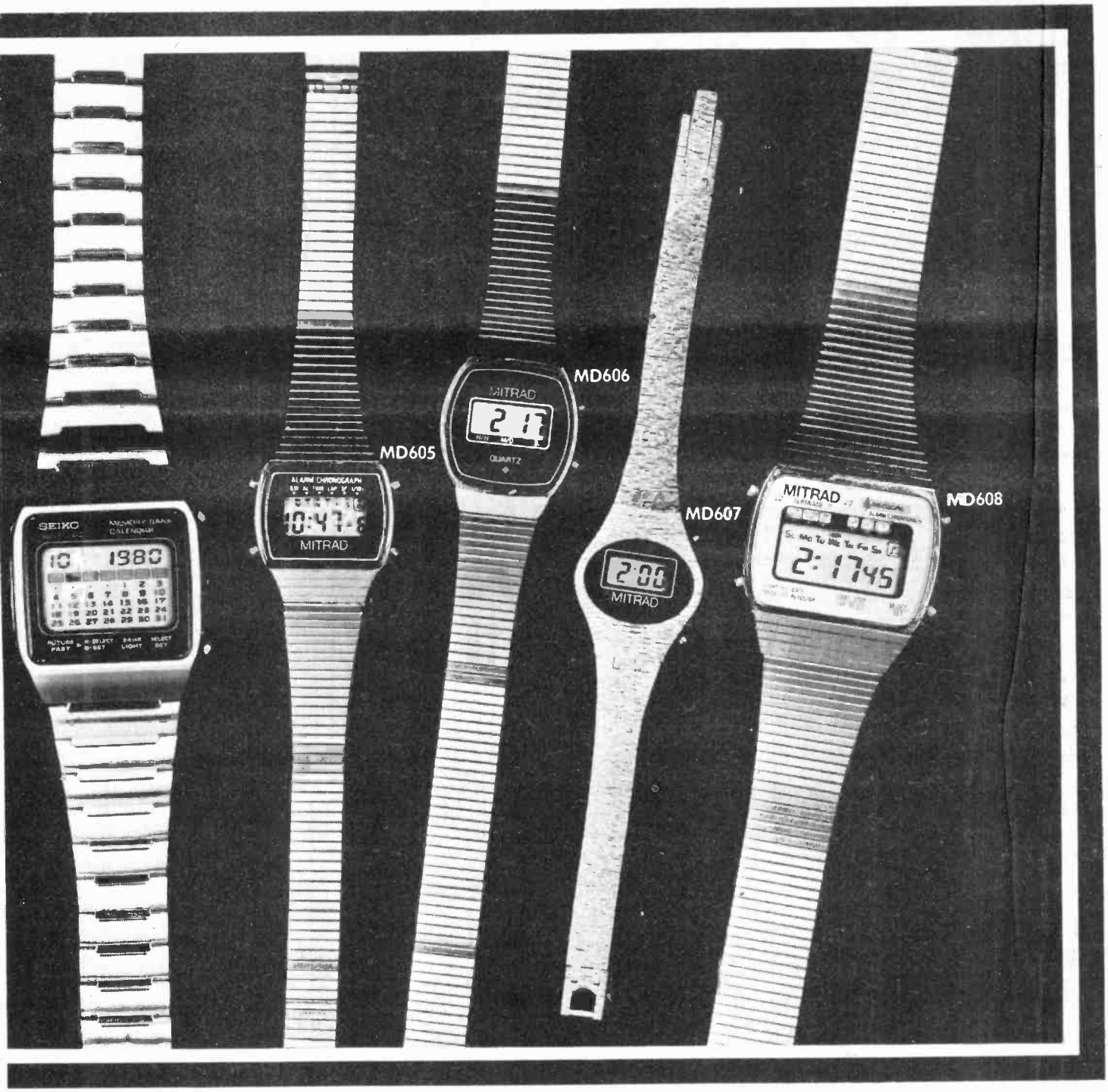

MD609 Gentleman's **super slim** flag date alarm. Only 4mm case thickness. Continuous display of hours, minutes, seconds and day; optional display of date, month, year. 24 hour alarm, alarm mode indication. Back light. Infinitely adjustable stainless steel strap. Very latest technology.
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MD610 Gentleman's dual time melody alarm chrono. Only 5mm case thickness. Continuous display of hours, minutes, seconds plus date and mode indications. 'Running horse' chrono to 1/10 sec, 12 hour alarm plays 30 seconds of 'Yellow Rose of Texas'. Infinitely adjustable stainless steel strap.
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MD605 Ladies musical alarm chrono. Continuous display of hours, minutes, seconds; optional display of day, date, month. Auto calendar. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise'. Back light. Infinitely adjustable stainless steel strap.
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MD606 Ladies five function fashion LCD watch with 3 year battery. Continuous display of hours and minutes, with month/date and date/seconds available. Auto calendar. Only 6mm case thickness. Back light. Infinitely adjustable stainless steel strap.
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MD607 Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.
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MD608 Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.
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ELECTRONIC CAPACITORS: (Values are in µF) **500V:** 10 **50p**; 47 **78p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8 **8p**; 10, 15, 22, **11p**; 32, 47, 50, **12p**; 63, 100, **27p**; **50V:** 50, 100, 220, **25p**; 470, **32p**; 1000, **80p**; **40V:** 2, 33, **8p**; 100, **12p**; 2200, 3300, **85p**; 4700, **98p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; **25V:** 10, 22, 47 100 **8p**; 160, 220, 250, **15p**; 470 **25p**; 640, 1000, **35p**; 1500, **40p**; 2200, **45p**; 3300, **77p**; 4700 **85p 16V:** 10, 47, **7p**; 100, 125, **8p**; 220, 330, **14p**; 470, **20p**; 1000, 1500, **30p**; 2200 **36p**; **10V:** 100, **7p**; 640, **12p**; 1000, **22p**.
TAG-END TYPE: 450V: 100µF **180p**; **70V:** 4700, **165p**; **64V:** 3300 **150p**; 2500 **110p**; **50V:** 4700, **150p**; 3300 **135p**; 2200 **99p**; **40V:** 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500 **90p**; **30V:** 4700 **110p**; **25V:** 15000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **85p**; 2200 **60p**.

POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **48p**; 1µF **64p**; 2µ2 **82p**.
160V: 10nF, 12n, 39n, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1µF **22p**; 2.2µF **32p**; 4.7µF **36p**.
100V: 10n, 15n **20p**; 22n **22p**; 47n **25p**; 100n **38p**; 470n **80p**; 1µF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n **9p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n 13p; 470n **17p**; 680n **19p**; 1µ **22P**; 1µ5 **30p**; 2µ2 **34p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0-22, 0-33, 0-47, 0-68, 1-0µ, 2.2µF, 3-3, 4-7 **25V:** 10, **20V:** 6µ8. **16V:** 2µ2, 4µ7, **10 15p**.
16V: 22µ **28p**, 47, 100 **50p**, 220 **80p**; **10V:** 15µ, 22µ, 33, **24p**; 100µ **35p**; **6V:** 47µ, 68, 100 **28p**; **3V:** 100 **20p**.

MYLAR FILM CAPACITORS
100V: 0-001, 0-002, 0-005, 0-01µF **8p**
0-015, 0-02, 0-04, 0-05, 0-056µF **7p**
0.1µF, 9p. **50V:** 0.47µF **12p**

CERAMIC CAPACITORS 50V
Range: 0-5pF to 10,000pF **4p**
0-015µF, 0-022µF, 0-033µF **6p**
0.047µF **5p**; 0.1µF, 0.2µF **7p**

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **11p** each
250, 270, 300, 330, 360, 390,
470, 600, 800, 820 **16p** each
1000, 1200, 1800, 2000 **28p** each

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 47nF **10p**

MINIATURE TYPE TRIMMERS
2.5-6pF; 3-10pF; 10-40pF **22p**
5-25pF; 5-45pF; 60pF; 88pF **30p**

COMPRESSION TRIMMERS
3-40pF; 10-80pF; 25-190pF **30p**
100-500pF **45p** 400-1250pF **58p**

GAS & SMOKE DETECTORS
TGS 812 & 813 **415p**; Socket **30p**

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & Lin.
470Ω, 680Ω, 1KΩ & 2KΩ (Linear only) **29p**
Single Gang **29p**
5KΩ-2MΩ Single Gang Log & Lin. **29p**
5KΩ-2MΩ Single Gang O/P Switch **69p**
5KΩ-2MΩ Double Gang Log & Lin **88p**
Wire Wound Single Turn 1 Watt
200Ω 20KΩ **105p**

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **60p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **36p**

PRESET POTENTIOMETERS
0.1W 50Ω—5MΩ Miniature Vertical & Horizontal **7p**
0-25W 100Ω—3-3MΩ horiz. larger **10p**
0-25W 200Ω—4-7MΩ Vert. **10p**
Cermet, Precision, multiturn, 0.75W ¾in 1000-100KΩ **90p**

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

RANGE	VAL	1-99	100+
¼W	2.2Ω-4.7M	E24	2p 1p
½W	2.2Ω-4.7M	E12	2p 1p
1W	2.2Ω-10M	E12	5p 4p
2%Metal Film	10Ω-1MΩ		6p 4p
1%0.5W	51Ω-1M	E24	8p 6p

100+ price applies to Resistors of each type not mixed values.

JACKSONS VARIABLE CAPACITORS

DILICON		0 2 365pF with slow	
100/300pF	205p	motion Drive	450p
500pF	250p	0 0 208/176	350p
6:1 Ball Drive		with slow	
4511/DAF	145p	motion drive	410p
Dial Drive 4103		C804-5pF: 1D: 15:	
6:1/36:1	775p	25: 50pF	250p
Drum 54mm	55p	100, 150pF	335p
0-1-365pF	325p	L 3x310pF	725p
00 2 365pF	395p	00-3x25pF	550p

RF CHOKES
1µH. 4.7. 10. 22. 33. 47. 100. 200. 470
750, 1mH. 2.5. 5. 10 **30p each**
43mH. 100 **60p each**

VEROBOARD

	0.1 (copper clad)	0.15	0.1 (plain)
2½ x 3¾"	**66p**	59p	**47p**
2½ x 5"	**75p**	69p	—
3¾ x 3¾"	**75p**	—	—
3¾ x 5"	**86p**	93p	**72p**
2½ x 17"	**225p**	—	—
3¾ x 17"	**296p**	260p	**210p**
4¾ x 17"	**387p**	—	—

Pkt. of 36 pins **20p** VQ Board **144p**
Pin insertion tool **147p** DIP Board **326p**
Spot face cutter **107p**. Veroblock **324p**

VERO WIRING PEN + Spool **350**
Spare Spool **85**
Combs **7**

DALO ETCH RESIST PEN
+ Spare tip **90**

FERRIC CHLORIDE
1 lb bag Anhydrious 225p + 40p P&P

ULTRASONIC TRANSDUCER
40KHz **350p pr**

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SR8P 9.5"×8.5"
6" x 6"	90p	110p	95p
6" x 12"	150p	195p	

DIL PLUGS (Headers)
14 pin **35p**; 16 pin **40p**
24 pin **85p**; 40 pin **295p**.

Ribbon Cable
10 way & 20 way available

Soldercon pins: 100 **60p**; 500 **275p**.

DIL SOCKETS (TEXAS) Low Wire

	Prof.	Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	46p
18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	30p	78p
28pin	35p	85p
36pin	—	105p
40pin	40p	109p

EDGE CONNECTORS: (Double type .1 .156)

2x10 way	—	85p
2x15 way	—	99p
2x18 way	115p	120p
2x22 way	130p	135p
2x25 way	149p	160p
2x30 way	170p	—
2x36 way	184p	—
2x40 way	210	—
2x43 way	232p	—

DIODES

BA102	25
AA119	18
AAZ15	15
BY100	24
BY126	12
BY127	12
CR033	157
OA9	50
OA47	12
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5404	17
IS44	20
IN5401	13
IN5402	14
IN5406	18
IN5408	30

BRIDGE RECTIFIERS (plastic case) p

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/400V	79
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V 1.3W **15p each**

Thyristors

IA/50V	37
IA/100V	42
IA/200V	47
IA/400V	56
5A400V	39
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A100V	42
12A300V	59
12A500V	92
12A800V	120
8T106	150
BT116	150
C106D	38
TIC44	22
TIC45	25
2N4444	140
2N5064	35

NOISE
Z5J **180**

VARICAPS

BA102	25
BB105B	40
BB106	40
MVAM2	165
MVAM115	140

TRIACS

3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	115
16A100V	110
16A400V	105
16A800V	195
25A500V	235
25A800V	195
T2800D	120

DIAC

ST2	20

75 SERIES

75108	350
75150	140
75154	150
75450	80
75451	75
75454	224
75491	89
75492	94

COMPUTER ICs

2114-450n	240
2114-300n	295
2708	445
27L08	995
2716-5V	750
4116	495
4047	750
6502	650
6520	350
6522	650
6530	1350
6532	850
6545	1450
6551	850
6592	2572
6800	700
6810	360
6821	500
6850	485
6852	485
8080A	490
8085A	1195
81LS95	135
81LS96	135
81LS97	140
8251	700
8253	1275
8T26A	235
8T28A	280
8T95N	160
8T97N	150
AY-3-1015	550p
AY-5-1013	395
AY-5-2376	980
DM8123	195
MC1488	90
MC1489	90
MC14411	1020
MC14412	1520
MK4027-2	450
MK4027-3	365
MK4027-4	350
MM5208D	TBA
MM8116N	TBA
MK4118-4	2099
RO-3-2513L	690
RO-3-2513U	650
SFF96364E	1050
SFC71301	820
TMS2516	850
TMS2716	1050
TMS4027	325
TMS4035	250
TMS4039	250
TMS4045	720
TMS4047	1083
TMS6011	365
Z80 CPU 2.5M	850
Z80A CPU4M	999
Z80 CTC	580
Z80A CTC	695
Z80 P10	610
Z80A P10	725

LINEAR ICs

702	75
709 14 pin	38
709C 8 pin	35
710	67
733	99
741 8 pin	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	390
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	160
AY-1-6721/6	210
AY-3-1270	840
AY-3-1350	795
AY-3-8500	990
AY-3-8910	850
AY-3-8912	795
AY-5-1224A	235
AY-5-1230	450
AY-5-1315	595
AY-5-1317A	630
AS-5-3500	510
AY-5-3507	415
AY-5-3600	1090
AY-5-4007D	650
AY-5-8100	735
CA3011	110
CA3012	150
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	71
CA3048	214
CA3059	175
CA3075	213
CA3080E	65
CA3081	190
CA3085	95
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8038CC	340
ICL8211	150
ICL8211A	150
ICM720A	550
ICM7205	1150
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7555	89
LD130	452
LF356	90
LM110	395
LM301AP	23
LM308T	70
LM311	80
LM318S	195
LM324A	45
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381N	145
LM382	125
LM384	130
LM386	99
LM387	150
LM389	93
LM1458	45
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM3915	240
LM3916	
LM733	99
LM13600	135
M252AA	625
M253AA	1150
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1312PQ	195
MC1458	45
MC1494	595
MC1495	350
MC1496L	92
MC1596	225
MC1710	79
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MC3405	150
MEM780	205
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	620
MSM5526	820
NE515	80
NE518	210
NE543K	210
NE544	185
NE555	22
NE556	55
NE560	325
NE561	395
NE562B	410
NE564	425
NE565A	120
NE566	160
NE567V	170
NE570	375
NE571	420
RC4136D	110
S5568	275
SAB3209	425
SAB3210	275
SAS560	150
SAS57D	150
SG3402	295
SL414A	150
SN76003N	240
SN76013	170
SN76013ND	130
SN76018	148
SN76023	170
SN76023ND	130
SN76033N	195
SN76115N	215
SN76131	110
SN76227N	95
SN76477	175
SN76660	120
SPB629	299
TAA621AX1	250
TAA661A	155
TAA700	353
TAA960	320
TAD100	159
TBA120S	70
TBA540Q	220
TBA550Q	330
TBA641-A12	
BX or BX11	250
TBA651	190
TBA800	90
TBA810	95
TBA820	70
TBA920Q	260
TBA990Q	270
TCA270Q	220
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA1490	290
TDA2020	320
TDA2030	300
TL061CP	54
TL062CP	125
TL064CN	159
TL071CP	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	70
TL083CP	95
TL084CN	120
UAA170	150
UAA180	150
XR2206	350
XR2266	750
ZN414	95
ZN423	195
ZN424E	130
ZN425E	415
ZN1034E	200
ZN1040E	685

TTL 74 (TEXAS)

7400	11
7401	12
7402	12
7403	14
7404	14
7405	18
7406	48
7407	48
7408	22
7410	9
7411	25
7412	20
7413	52
7414	31
7416	31
7417	19
7420	38
7421	26
7422	32
7423	44
7425	32
7426	35
7427	20
7428	28
7430	38
7432	
7433	
7437	35
7438	30
7440	20
7441	74
7442	71
7443	120
7444	116
7445	116
7446	132
7447	98
7448	99
7450	20
7451	20
7453	20
7454	20
7460	20
7470	41
7472	31
7473	40
7474	34
7475	56
7476	41
7480	55
7481	120
7482	75
7483	94
7484	113
7485	121
7486	33
7489	215
7490	57
7491	85
7492	59
7493	59
7494	95
7495	75
7496	95
7497	180
74100	130
74104	62
74105	62
74107	35
74109	60
74110	54
74111	68
74112	150
74116	198
74118	99
74119	125
74120	105
74121	42
74122	55
74123	95
74125	45
74126	55
74128	74
74132	70
74136	65
74141	85
74142	195
74143	350
74144	350
74145	90
74147	180
74148	145
74150	150
74151	75
74153	75
74154	140
74155	75
74156	80
74157	75
74159	185
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	155
74167	240
74170	230
74172	420
74173	120
74174	105
74175	82
74176	90
74177	90
74178	149
74179	155
74180	90
74181	290
74182	88
74184	145
74185	145
74188	299
74190	135
74191	135
74192	135
74193	135
74194	105
74195	198
74196	130
74197	90
74198	195
74199	198
74221	140
74246	195
74247	195
74248	195
74249	195
74251	120
74265	63
74273	270
74278	220
74279	99
74283	150
74284	385
74285	385
74290	125
74293	125
74297	236
74298	185
74365	90
74366	90
74367	90
74368	90
74390	185
74393	185
74490	150

74L

74L00	78
L30	80
L47	395
L75	220
L86	360
L121	195
L123	340

74S

74S00	60
S04	73
S132	350
S138	250
S158	524
S188	210
S189	158
S194	195
S195	795
S241	195
S262	895
S287	325
S288	210
S470	325
S472	1150
S475	825

74LS

LS00	13
LS01	15
LS02	15
LS03	23
LS04	20
LS05	23
LS08	23
LS09	23
LS10	20
LS11	32
LS12	32
LS13	40
LS14	75
LS15	40
LS20	21
LS21	32
LS22	40
LS26	48
LS27	45
LS28	48
LS30	24
LS32	30
LS33	39
LS37	39
LS38	39
LS40	28
LS42	80
LS47	85
LS48	120
LS49	120
LS51	25
LS54	30
LS55	70
LS63	150
LS73	40
LS74	40
LS75	48
LS76	45
LS78	45
LS83	105
LS85	105
LS86	45
LS90	50
LS91	125
LS92	75
LS93	75
LS95	115
LS96	180
LS107	45
LS109	75
LS112	80
LS113	65
LS114	49
LS122	70
LS123	95
LS124	180
LS125	60
LS126	80
LS132	95
LS136	55
LS138	70
LS139	90
LS145	120
LS147	210
LS148	175
LS151	96
LS153	85
LS155	96
LS156	96
LS157	76
LS158	85
LS160	120
LS161	98
LS162	110
LS163	100
LS164	115
LS165	155
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	147
LS175	110
LS181	295
LS183	298
LS189	120
LS190	120
LS191	120
LS192	125
LS193	125
LS194	125
LS195	125
LS196	120
LS197	120
LS200	345
LS202	345
LS221	120
LS240	225
LS241	225
LS242	232
LS243	232
LS244	225

SPECIAL OFFER
2114-450n **225p**
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MM1702AQ **295p**

Telephone orders now accepted (£10 min.)

1N1304	50
1N1305	35
1N1306	40
1N1307	45
1N1308	50
1N1613	23
1N1670	150
1N1671B	120
2N1893	120
2N2160	350
2N2217	43
2N2218A	34
2N2219A	22
2N2220A	23
2N2221A	23
2N2222A	20
2N2297	45
2N2303	45
2N2368	21
2N2369A	17
2N2476	120
2N2483	28
2N2484	30
2N2492	50
2N2497	50
2N2646	48
2N2784	55
2N2904	26
2N2905A	26
2N2906	22
2N2907	22
2N2907A	22
2N2926G	10
2N3011	24
2N3020	33
2N3053	24
2N3054	55
2N3055	48
2N3108	32
2N3252	36
2N3302	26
2N3441	140
2N3442	140
2N3663	17
2N3702	10
2N3703	10
2N3704	10
2N3705	10
2N3706	12
2N3707	12
2N3708	11
2N3709	11
2N3710	10
2N3711	12
2N3713	140
2N3771	179
2N3772	195
2N3773	288
2N3819	20
2N3820	45
2N3822	130
2N3823	70
2N3824	70
2N3866	90
2N3879	150
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037	58
2N4041	40
2N4058	15
2N4061	17
2N4062	17
2N4064	115
2N4220	60
2N4234	36
2N4236	45
2N4264	24
2N4286	18
2N4289	18
2N4314	61
2N4400	20
2N4427	80
2N4859	65
2N4871	55
2N4898	135
2N4901	160
2N4921	40
2N4922	55
2N5102	125
2N5135	21
2N5136	21
2N5138	28
2N5172	25
2N5179	60
2N5180	38
2N5191	75
2N5305	20
2N5308	20
2N5457	35
2N5458	35
2N5459	35
2N5485	40
2N5777	45
2N5879	140
2N6027	44
2N6388	126
2SD234	50
3N128	112
3N140	112

WATFORD ELECTRONICS

COMPUTER CORNER

- **SUPERBOARD II** Ready-built and tested **Only £150**
- **PSU 5V/3A** (for above incl. RF Modulator) **£25**
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- **Extra 4K RAM** (8x2114) **£18**
- **Plastic Case** Black, fits UK101 Superboard, NASCOM II etc **£25**
- **SUPERPRINT 800.** 80 column Hugh Performance Impact Printer. Ideal for PET, NASCOM, UK101, Superboard, TRS80 etc. **only £325**
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  Ready-built and tested **£120**
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- **UHF Modulators** 6MHz **280p**
  UHF Modulators 8MHz **450p**
- **KEYPADS** 4 x 4 matrix **350p**
- **Full ASCII** coded 56 Key Keyboard Mod. 756 **£40**
- **10x C12 Cassettes** in Rack **£5.50**
  (P&P is extra on all items) Call in at our shop for Demo or write in for leaflets.

SWITCHES
TOGGLE: 2A. 250V.

SPST	32p
DPST	34p
DPDT	44p
4 pole on/off	54p

SUB-MIN TOGGLE

SP changeover	59p
SPST on/off	64p
SPST biased	85p
DPDT 6 tags	70p
DPDT centre off	79p
DPDT biased	115p

SLIDE 250V:

1A DPDT	14p
1A DPDT c/over	15p
½A DPDT	13p
4 pole 2-way	24p

PUSH BUTTON
DPDT Black Body
Red, Blue, Grn., Yell.
SRL Latching 125p
SRM Momentary 125p

MINI. Non Locking

Push to Make	15p
Push Break	25p

DIL SWITCHES
(SPST)
4 way 85p; 6 way 95p; 8 way 115p

ROTARY: Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers **90p**
Mains Switch DPST to fit **40p**
Break Before Make Wafers. 1 pole/12 way. 2p/6 way. 3p/4 way. 4p/3 way. 6p/2 way **66p**
Spacer and Screen **6p**
ROTARY: (Adjustable Stop)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **43p**
ROTARY: Mains 250V AC. 4 Amp **52p**

'D' CONNECTORS (Cannon type)

	Plugs	Sockets	Covers
9way	95p	128p	—
15way	135p	195p	150p
25way	198p	284p	170p
37way	290p	398p	185p

CRYSTALS

100KHz	323
455KHz	383
1MHz	323
1.008M	395
1.28MHz	392
1.6MHz	323
1.8MHz	323
1.8432MHz	362
2.4576MHz.	362
3.2768M	323
3.57954M	195
4.000MHz	290
4.032MHz	323
4.433619M	135
5.0MHz	355
5.185M	323
5.24288M	425
6.0MHz	323
6.5536M	200
7.680M	323
8.0MHz	392
8.08333M	362
8.867237M	362
9.375M	323
10.0MHz	323
10.7MHz	323
12MHz	392
14.31818M	362
18MHz	323
18.432M	323
20.0MHz	323
27.648M	323
38.6667M	350
48.0MHz	323
100.00MHz	323

ETI Projects: Parts available for: Digital Test Meter, DM900, 60W Amplifier System. Send SAE plus 5p for list.

TRANSFORMERS (Mains Prim. 220-240V)
6-0-6V; 9-0-9V; 12-0-12V 100mA **95p**
3VA: 0-6V 0-6V (PCB mounting) **150p**
8VA: 6V-.5A 6V-.5A; 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A **215p**
12V: 4.5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; 12V-.5A 12V-.5A; 15V-.4A 15V-.4A; 20V-.3A 20V-.3A **235p** (30p p&p)
24VA: 6V-1.5A 6C-1.5A; 9V-1.3A 9V-1.3A; 12V-1A 12V-1A; 15V-.8A 15V-.8A; 20V-.6A 20V-.6A **320p** (55p p&p).
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-.8A 30V-.8A **365p** (60p p&p).
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A **595p** (74p p&p). (NB: p&p charge to be added above our normal postal charge.)

ALUM. BOXES WITH LID

	p
3x2x1"	55
2¼x5¼x1½"	75
4x4x1½"	75
4x2¾x1½"	75
4x5¼x1⅝"	100
4x2½x2"	80
5x4x2"	107
6x4x2"	110
7x5x2½"	185
8x6x3"	185
10x7x3"	240
10x4¼x3"	228
12x5x3"	230
12x8x3"	275

PANEL METERS

FSD
60x46x
35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
'S' 'VU'
445p each
4¼x3¼x1½"
0-50μA
0-100μA
0-500μA
595p each

VOLTAGE REGULATORS

		+ ve	−ve	
1A	TO3			
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		—
18V	7818	145p		—
1A	TO220	Plastic Casing		
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p		—
100mA	TO92	Plastic Casing		
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

LM300H	170p	LM327	270p
LM305H	140p	LM723	38p
LM309K	135p	TAA550	50p
LM317K	350p	TBA625B	95p
LM323K	550p	TDA1412	150p
LM325N	240p	78H05 + 5V/5A	595p
LM326N	240p	78HG +5V to +25V 5A	650p

OPTO

LEDs with Clips	
TIL209 Red	13
TIL211 Grn	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow or Amber	18
Square LEDs, Red,	18
Green, Yellow	30
LD271 Infra Red	40
SFH205 Detector	90
TIL32 Infra Red	65
TIL78 Detector	75
BARGRAPY. Red 10 segments	225
LS400	255
OCP71	120
ORP12	63
ORP61	85
2N5777	45

ISOLATORS

IL74	55
TIL111/2	85
TIL114	95
TIL117	110

7 Segment Displays

TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
DL747 .6" CA	180
.8" Orange CA	250
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
DVM176	**1885**
LCD 3½ Digits	775
LCD 4 Digits	975
LCD 6 Digits	950

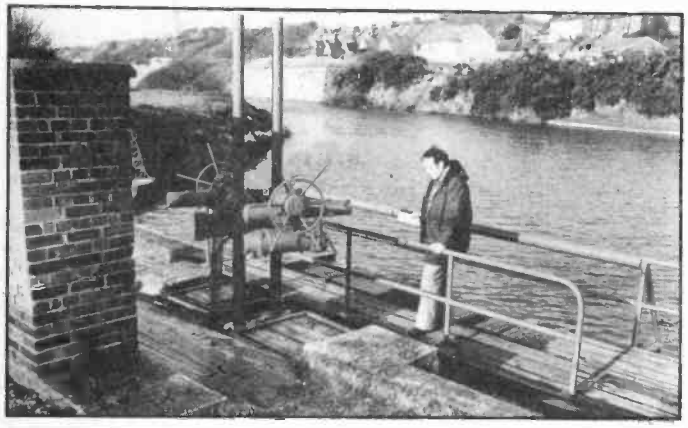
LS245	450	LS373	180	4015	85	4053	80
LS247	135	LS374	180	4016	42	4054	130
LS248	135	LS375	150	4017	82	4055	135
LS249	135	LS377	199	4018	28	4056	135
LS251	130	LS378	185	4019	48	4057	2650
LS253	130	LS379	215	4020	99	4059	575
LS257	115	LS384	50	4021	105	4060	130
LS258	120	LS385	420	4022	95	4061	1225
LS259	160	LS386	85	4023	25	4062	995
LS261	450	LS390	140	4024	75	4063	120
LS266	75	LS393	140	4025	25	4066	58
LS273	180	LS395	210	4026	180	4067	430
LS275	320	LS396	199	4027	48	4068	26
LS279	88	LS398	275	4028	82	4069	26
LS280	250	LS399	230	4029	105	4070	30
LS283	190	LS445	140	4030	60	4071	25
LS290	130	LS447	195	4031	225	4072	25
LS293	130	LS490	150	4032	125	4073	25
LS295	215	LS668	105	4033	175	4075	25
LS298	215	LS669	105	4034	210	4076	99
LS299	420	LS670	270	4035	125	4077	48
LS300	175	LS673	750	4036	365	4078	30
LS302	175	LS674	850	4037	115	4081	28
LS320	270			4038	118	4082	28
LS323	450	**CMOS**		4039	360	4085	90
LS324	200	4000	18	4040	105	4086	90
LS325	320	4001	18	4041	80	4089	150
LS326	330	4002	24	4042	80	4093	89
LS327	315	4006	92	4043	95	4094	240
LS346	185	4007	22	4044	95	4095	105
LS347	150	4008	82	4045	175	4096	105
LS348	190	4009	40	4046	130	4097	350
LS352	185	4010	48	4047	98	4098	115
LS353	185	4011	24	4048	65	4099	190
LS355	65	4012	24	4049	45	4160	125
LS366	65	4013	45	4050	48	4161	125
LS367	65	4014	85	4051	80	4162	125
LS368	65			4052	80	4163	125

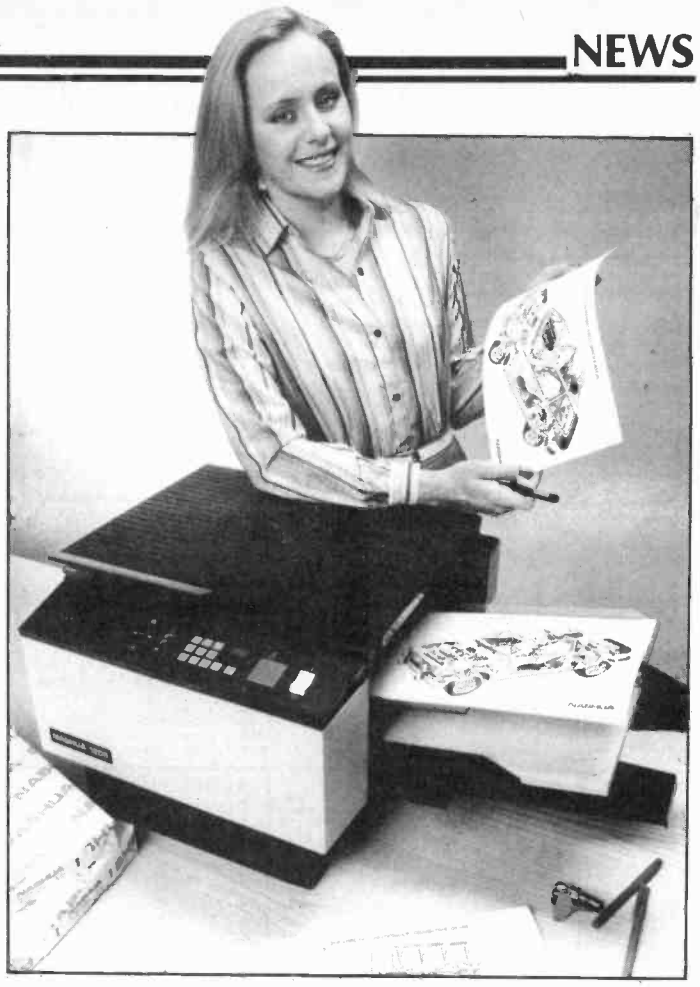
4174	130	4521	250
4175	120	4522	150
4194	125	4526	150
4408	790	4527	160
4409	790	4528	120
4410	790	4529	175
4411	1020	4530	89
4412F	1520	4531	165
4412V	1520	4532	140
4415F	850	4534	575
4415V	850	4536	395
4419	320	4538	160
4422	570	4539	135
4432	1050	4541	150
4435	1050	4543	175
4440	999	4549	296
4450	350	4553	440
4451	350	4554	175
4452		4555	85
4490F	750	4556	75
4490V	750	4557	425
4501	28	4558	130
4502	125	4559	290
4503	75	4560	235
4506	75	4561	95
4507	60	4562	595
4508	325	4566	190
4510	99	4568	299
4511	150	4569	250
4512	98	4572	48
4513	225	4580	595
4514	265	4581	350
4515	299	4582	150
4516	120	4583	125
4517	450	4584	64
4518	105	4585	140
4519	70	40106	95
4520	115		

DIGEST

High Level Control

A system for regulating the level of the Royal Military Canal in Kent has been installed by Shepway District Council. The fully automatic system was devised and commissioned by Rotork Retrofit of Bath and utilises a pressure transducer which senses a predetermined water level and intiates the raising of the water gates to allow water to flow beneath and so maintain a safe level. The electronic control system is housed in a weatherproof cabinet on the site and is programmed to provide four stages of control in winter and three in summer. In summer a high level is maintained to cater for the needs of pleasure boats and anglers. The automatic control ensures that this high level is maintained even in times of heavy rainfall to prevent fish being lost out at sea, which occurred before. During the winter the canal is tidelocked during high tide conditions and this has led in the past to incidents of flooding. Previously the gates had to be left in a partly open position and this necessitated having staff 'on call' day and night to adjust them manually whenever tide or weather caused problems. The new system saves time, money and staff inconvenience.





Copycat

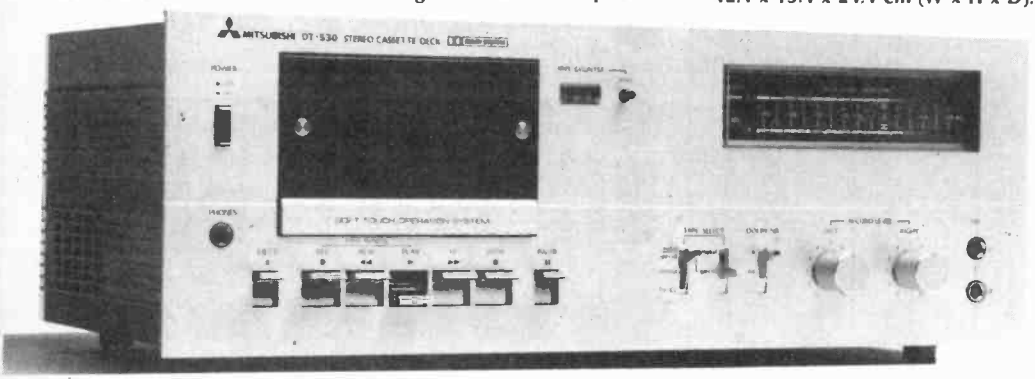
Nashua have introduced what they consider to be the smallest plain paper copier in the world. Measuring only 18" x 18" ' 13", the Nashua 1205 will make its UK exhibition debut at the London Business Show on September 23-26. It is designed for the small business where inexpensive decentralised copying is required. The 1205 utilises fibre optics combined with a miniaturised development of Nashua's microprocessor controlled Liquid Toner Transfer system to achieve its small size. The first copy is ready in 7 S, subsequent copies at 12 per minute and the single paper tray can hold a range of paper from A5 to 8.5" x 14.0". There is an automatic shut-off 60 S after the last copy is produced and the toner/developer is held in self-contained cartridges. The machine also has improved copy (especially blue response), adjustable exposure control and a touch-tone keyboard with a digital readout to keep track of copy countdown. For further information contact Nashua Copycat Ltd, Cory House, Bracknell, Berkshire, RG12 1ET.

Cassette Interface PCB

We omitted to include a Buy-lines section in the Cassette Interface project published last month. Jayman Electro Devices, 15 Ash Grove, Springhead, Oldham, Lancs OL4 4RP will supply a PCB for £4 all inclusive or a complete kit (including PCB) for £13.50 including post and VAT.

Getting It Taped

Mitsubishi Electric have launched their new metal tape cassette deck, the DT-530. For £122.00 you can enjoy such features as soft touch operation and one-touch recording, together with Dolby noise reduction and peak level indicators for accurate reading. Fifteen LEDs per channel provide an easy-to-read scale from −20 dB to +5 dB and at 0 dB the scale colour changes from green to red. The cassette housing on the front loading deck is air-damped and features background cassette illumination and a smoked glass front which detaches simply to facilitate head cleaning. Wow and flutter is 0.07% W RMS, S/N ratio (at 400 Hz) weighted, Dolby NR in, is 64 dB and frequency response (metal, special Fe-Cr) is 30 Hz to 16 kHz. Dimensions are 42.4 x 15.4 x 24.4 cm (W x H x D).



24 Hour Fone Machine

Most telephone answering machines lie redundant in the office all day, only bursting into action when everyone has gone home. The Ansafone 6A has been designed to be useful 24 hours a day.

In addition to providing telephone answering and simple announcement facilities, the 6A doubles as a simple-to-use dictation machine. It can also be used as a music cassette player for background music.

Ansafone 6A is available on rental from £2.35 per week from Ansafone, Lyon May, Frimley Road, Camberley, Surrey GU16 5EY.

TRANSCENDENT DPX

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr — published in Electronics Today International

The Transcendent DPX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic strong sounds.

Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £299 +VAT

To add interest to the sounds and make them more natural there is a chorus / ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects. As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.)
Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.
The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

POWERTRAN

MANY MORE KITS ON PAGE 116. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noice generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

COMPLETE KIT ONLY £168.50+VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)

TTLs by TEXAS

7400	11p	74293	150p	4020	100p
74S00	60p	74298	200p	4021	110p
7401	12p	74365	100p	4022	100p
7402	12p	74366	100p	4023	27p
7403	14p	74367	100p	4024	50p
7404	14p	74368	100p	4025	20p
7405	18p	74390	200p	4026	130p
7406	36p	74393	200p	4027	50p
7407	36p	74490	225p	4028	84p
7408	17p	**74LS SERIES**		4029	100p
7409	19p	74LS00	14p	4030	55p
7410	15p	74LS02	16p	4031	200p
7411	24p	74LS03	18p	4034	200p
7412	20p	74LS04	16p	4035	110p
7413	30p	74LS05	25p	4036	295p
7414	40p	74LS08	22p	4039	295p
74C14	90p	74LS09	21p	4040	100p
7416	27p	74LS10	20p	4041	80p
7417	27p	74LS11	40p	4042	80p
7420	17p	74LS13	40p	4043	90p
7421	40p	74LS14	50p	4044	90p
7422	22p	74LS20	20p	4046	110p
7423	34p	74LS21	40p	4047	100p
7425	30p	74LS27	38p	4048	55p
7426	40p	74LS30	20p	4049	45p
7427	34p	74LS32	27p	4050	45p
7428	36p	74LS37	30p	4051	80p
7430	17p	74LS38	38p	4052	80p
7432	30p	74LS42	70p	4053	80p
7433	40p	74LS47	75p	4054	150p
7437	35p	74LS51	24p	4055	125p
7438	35p	74LS55	30p	4056	135p
7440	17p	74LS73	50p	4059	600p
7441	70p	74LS74	27p	4060	115p
7442A	60p	74LS75	36p	4063	120p
7443	112p	74LS76	45p	4066	50p
7444	112p	74LS83	70p	4067	450p
7445	100p	74LS85	80p	4068	27p
7446A	93p	74LS86	40p	4069	20p
7447A	75p	74LS90	40p	4070	30p
7448	80p	74LS92	70p	4071	25p
7450	17p	74LS93	60p	4072	25p
7451	17p	74LS96	110p	4073	25p
7453	17p	74LS107	45p	4075	25p
7454	17p	74LS109	80p	4076	107p
7460	17p	74LS112	40p	4081	27p
7470	36p	74LS113	90p	4082	27p
7472	30p	74LS114	45p	4086	72p
7473	34p	74LS122	80p	4089	150p
7474	30p	74LS123	60p	4093	70p
7475	38p	74LS124	180p	4094	250p
7476	32p	74LS125	50p	4095	95p
7480	50p	74LS126	50p	4096	95p
7481	100p	74LS132	60p	4097	340p
7482	84p	74LS133	30p	4098	120p
7483a	90p	74LS136	55p	4099	200p
7484	100p	74LS138	65p	40100	220p
7485	110p	74LS139	75p	40101	132p
7486	34p	74LS145	120p	40102	180p
7489	210p	74LS147	220p	40103	180p
7490A	30p	74LS148	175p	40104	99p
7491	80p	74LS151	80p	40105	120p
7492A	46p	74LS153	60p	40106	90p
7493A	36p	74LS154	200p	40107	60p
7494	84p	74LS155	80p	40108	470p
7495A	70p	74LS156	90p	40109	100p
7496	65p	74LS157	60p	40110	300p
7497	180p	74LS158	60p	40114	250p
74100	130p	74LS160	90p	4502	120p
74107	34p	74LS161	75p	4503	70p
74109	55p	74LS162	140p	4507	55p
74116	200p	74LS163	100p	4508	290p
74118	130p	74LS164	90p	4510	99p
74119	210p	74LS165	140p	4511	120p
74120	110p	74LS166	180p	4512	80p
74121	34p	74LS173	110p	4514	250p
74122	48p	74LS174	100p	4515	300p
74123	60p	74LS175	100p	4516	110p
74125	75p	74LS181	320p	4518	100p
74126	60p	74LS190	100p	4520	100p
74128	75p	74LS191	100p	4521	250p
74132	75p	74LS192	100p	4526	108p
74136	75p	74LS193	100p	4527	150p
74137	50p	74LS195	140p	4528	100p
74141	50p	74LS196	120p	4532	140p
74142	200p	74LS197	90p	4534	550p
74145	90p	74LS221	120p	4536	375p
74147	190p	74LS240	175p	4538	120p
74148	150p	74LS241	175p	4543	180p
74150	130p	74LS242	170p	4553	320p
74151A	70p	74LS243	170p	4556	72p
74153	70p	74LS244	150p	4560	200p
74154	120p	74LS245	250p	4569	250p
74155	90p	74LS247	140p	4572	40p
74156	90p	74LS251	140p	4583	110p
74157	70p	74LS253	90p	4584	90p
74159	190p	74LS257	90p	4585	150p
74160	100p	74LS258	160p	4724	250p
74161	100p	74LS259	160p	40097	90p
74162	100p	74LS266	100p	14411	1100p
74163	100p	74LS273	170p	14412	1100p
74164	120p	74LS279	90p	14433	1100p
74165	130p	74LS283	90p	14500	700p
74166	120p	74LS298	160p	14599	290p
74167	200p	74LS323	400p	**INTERFACE ICs**	
74170	240p	74LS324	200p	AD536A	130p
74172	450p	74LS348	200p	AD561J	1400p
74173	120p	74LS365	48p	AD7524	600p
74174	90p	74LS367	70p	DM8123	175p
74175	85p	74LS368	100p	DM8131	375p
74176	90p	74LS373	150p	DP8304	450p
74177	90p	74LS374	150p	DS8835	250p
74178	160p	74LS375	120p	DS8836	150p
74180	93p	74LS377	160p	DS8838	225p
74181	160p	74LS378	140p	MC1488	75p
74182	90p	74LS390	120p	MC1489	75p
74184A	150p	74LS393	120p	25S10	350p
74185	150p	74LS445	140p	75107	160p
74186	500p	74LS668	100p	75110	325p
74188	325p	74LS670	400p	75150	175p
74190	120p	**4000 SERIES**		75154	175p
74191	120p	4000	15p	75182	230p
74192	100p	4001	22p	75322	300p
74193	100p	4002	20p	75324	375p
74194	120p	4006	95p	75325	375p
74195	95p	4007	20p	75361	300p
74196	95p	4008	80p	75363	400p
74197	80p	4009	40p	75365	200p
74198	150p	4010	50p	75451/2	72p
74199	150p	4011	20p	75491/2	70p
74221	160p	4012	25p	BT26	160p
74251	140p	4013	50p	BT28	250p
74259	250p	4014	84p	BT95	200p
74278	290p	4015	84p	BT97	160p
74279	110p	4016	45p	B1LS95	120p
74283	140p	4017	70p	B1LS96	140p
74284	360p	4018	89p	B1LS97	120p
74285	360p	4019	45p	B1LS98	140p
		9601	110p		

93 SERIES

9301	160p	74S00	60p	74S114	120p
9302	175p	74S04	60p	74S124	300p
9308	316p	74S05	75p	74S132	160p
9310	275p	74S08	75p	74S133	75p
9311	275p	74S10	60p	74S138	225p
9312	160p	74S20	60p	74S139	225p
9314	165p	74S30	60p	74S157	250p
9316	225p	74S32	90p	74S174	250p
9321	225p	74S37	90p	74S175	320p
9322	150p	74S64	60p	74S194	350p
9334	360p	74S74	90p	74S241	450p
9368	250p	74S85	300p	74S260	70p
9370	300p	74S86	180p	74S373	500p
9374	200p	74S112	120p	74S374	500p

LINEAR I.Cs

AY1-0212	600p	MC1458	48p
AY1-1313	668p	MC1495L	350p
AY1-1320	320p	MC1496	70p
AY1-5050	140p	MC3340P	120p
AY3-1270	840p	MK50398	750p
AY3-8912	650p	ML920	775p
AY5-1224A	240p	MM57160	620p
AY5-1315	600p	NE531	150p
AY5-1317A	775p	NE555	20p
AY5-40070	520p	NE556	70p
CA3019	80p	NE562B	425p
CA3046	70p	NE564	420p
CA3048	225p	NE565	130p
CA3080E	72p	NE566	155p
CA3086	48p	NE567	140p
CA3089E	225p	NE571	425p
CA3090AQ	375p	NE5534A	250p
CA3130E	90p	S566B	270p
CA3140E	50p	SAD1024A	1250p
CA3160E	100p	SFF96364	1100p
CA3161E	140p	SL490	400p
CA3162E	450p	SN76003N	250p
CA3189E	300p	SN76013N	140p
CA3280	160p	SN76013ND	120p
DAC1408-8	200p	SN76023N	140p
FX209	750p	SN76477	175p
ICL7106	850p	SP8515	750p
ICL8038	300p	TAA621	275p
ICM7555	80p	TBA641B11	225p
LF13331	310p	TBA651	200p
LF351	48p	TBA800	90p
LF356P	95p	TBA810	100p
LM10C	425p	TBA820	90p
LM301A	27p	TBA950	300p
LM311	70p	TCA210	250p
LM318	200p	TCA220	350p
LM319	225p	TCA940	175p
LM324	45p	TDA1004	300p
LM339	75p	TDA1008	320p
LM348	95p	TDA1010	225p
LM377	175p	TDA1022	570p
LM380	75p	TDA1024	120p
LM381AN	180p	TDA1034B	250p
LM386	95p	TDA1170	300p
LM393	100p	TDA2002V	325p
LM709	36p	TDA2020	320p
LM710	50p	TL071/81	45p
LM725	350p	TL072/82	75p
LM733	100p	TL074	130p
LM741	18p	TL084	110p
LM747	70p	TL170	50p
LM748	35p	UAA170	175p
LM2917	250p	UDN6118	320p
LM3900	70p	UDN6184	320p
LM3909	70p	ULN2003	100p
LM3911	130p	XR2206	300p
LM3914	225p	XR2207	400p
LM3915	225p	ZN414	90p
LM4136	120p	ZN419C	225p
LM13600	125p	ZN424E	135p
MC1310P	150p	ZN425E	400p
		ZN427E	750p

VOLTAGE REGULATORS

Fixed Plastic TO-220

	+ve				
1A					
5V	7805	60p		7905	65p
12V	7812	60p		7912	65p
15V	7815	60p		7915	70p
18V	7818	60p		7918	70p
24V	7824	60p		7924	70p
100mA	TO-92				
5V	78L05	30p		79L05	70p
12V	78L12	30p		79L12	70p
15V	78L15	30p		79L15	70p

OTHER REGULATORS		78HGKC	600p
LM309K	135p	78HO5KC	550p
LM317T	200p	78MGT2C	135p
LM323K	500p	79HGKC	600p
LM723	37p	TL497	300p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	90p	ORP61	120p
ORP12	120p	TIL78	55p
OPTO-ISOLATORS			
ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular	
TIL216 Red	18p	LEDs (R. G. Y)	30p
0.2"		NSB5881	570p
TIL220 Red	16p	TIL311	600p
TIL222 Gr	18p	TIL312/3	110p
TIL228 Red	22p	TIL321/2	130p
Rectangular LEDS		TIL330	140p
(R. G. Y)	30p	7750/60	200p

DISPLAYS

3015F	200p	**DRIVERS**	
OL704	140p	9368	250p
DL707 Red	140p	9370	300p
		UDN6118	320p
		UDN6184	320p

TRANSISTORS

AC126	25p	BFR40	25p	TIP30C	60p
AC127/8	20p	BFR41	25p	TIP31A	58p
AC176	25p	BFR79	25p	TIP31C	62p
AC187/8	25p	BFR80	25p	TIP32A	68p
AF116	50p	BFR81	25p	TIP32C	82p
AD149	70p	BFX29	40p	TIP33A	90p
AD161/2	45p	BFX30	34p	TIP33C	114p
AU107	200p	BFX84/5	40p	TIP34A	115p
BC107/8	11p	BFX86/7	30p	TIP34C	160p
BC109	11p	BFX88	30p	TIP35A	225p
BC117	20p	BFW10	90p	TIP35C	290p
BC147/8	9p	BFY50	30p	TIP36A	270p
BC149	10p	BFY51/2	30p	TIP36C	340p
BC157/8	10p	BFY56	33p	TIP41A	65p
BC159	11p	BFY90	90p	TIP41C	78p
BC169C	12p	BRY39	45p	TIP42A	70p
BC172	12p	BSX19/20	20p	TIP42C	82p
BC177/8	17p	BU104	225p	TIP54	160p
BC179	18p	BU105	190p	TIP120	120p
BC182/3	10p	BU108	250p	TIP122	130p
BC184	11p	BU109	225p	TIP142	130p
BC187	30p	BU180A	120p	TIP147	130p
BC212/3	11p	BU205	200p	TIP2955	78p
BC214	12p	BU208	200p	TIP4055	70p
BC237	15p	BU406	145p	TIS43	45p
BC327	16p	E300	50p	TIS93	30p
BC337	16p	E308	50p	ZTX108	12p
BC338	16p	E310	50p	ZTX300	13p
BC461	36p	MJ2501	225p	ZTX500	15p
BC477/8	30p	MJ2955	90p	ZTX502	18p
BC516/7	40p	MJ3001	225p	ZTX504	30p
BC547B	16p	MJE340	50p	2N457A	250p
BC548C	9p	MJE2955	100p	2N696	35p
BC549C	18p	MJE3055	70p	2N697	25p
BC557B	16p	MPF102	45p	2N698	45p
BC559C	18p	MPF103/4	40p	2N706A	30p
BCY70	18p	MPF105/6	40p	2N708	30p
BCY71/2	22p	MPS6531	50p	2N918	45p
BD131/2	50p	MPS6534	50p	2N930	18p
BD135/6	54p	MPSA06	30p	2N1131/2	36p
BD139	56p	MPSA12	50p	2N1613	25p
BD140	60p	MPSA13	50p	2N1711	25p
BD189	60p	MPSA20	50p	2N2102	70p
BD232	95p	MPSA42	50p	2N2160	350p
BD233	75p	MPSA43	50p	2N2219A	30p
BD235	85p	MPSA56	32p	2N2222A	30p
BD241	70p	MPSA70	50p	2N2369A	25p
BD242	70p	MPSU06	63p	2N2484	30p
BDY56	200p	MPSU07	60p	2N2646	45p
BF200	32p	MPSU45	90p	2N2904/5	30p
BF244B	35p	MPSU65	78p	2N2906A	30p
BF256B	70p	OC28	130p	2N2907A	30p
BF257/8	32p	OC35	130p	2N2926	9p
BF259	36p	TIP29A	40p	2N3053	30p
BFR39	25p	TIP29C	55p	2N3054	65p
		TIP30A	48p	2N3055	48p

2N3442	140p	40290	250p
2N3553	240p	40360	40p
2N3565	30p	40361/2	75p
2N3584	250p	40364	120p
2N3643/4	48p	40408	90p
2N3702/3	12p	40409	100p
2N3704/5	12p	40410	100p
2N3706/7	14p	40411	300p
2N3708/9	12p	40594	120p
2N3773	300p	40595	120p
2N3819	25p	40673	75p
2N3820	50p	40841	90p
2N3823	70p	40871/2	100p
2N3866	90p		
2N3902	700p		
2N3903/4	18p		
2N3905/6	20p		
2N4037	65p		
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2N4061/2	18p		
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2N4125/6	27p		
2N4401/3	27p		
2N4427	90p		
2N4871	60p		
2N5087	27p		
2N5089	27p		
2N5172	27p		
2N5179	90p		
2N5191	90p		
2N5194	90p		
2N5245	40p		
2N5296	55p		
2N5401	50p		
2N5457/8	40p		
2N5459	40p		
2N5460	60p		
2N5485	44p		
2N5875	250p		
2N6027	48p		
2N6041	160p		
2N6044	160p		
2N6052	300p		
2N6059	325p		
2N6107	65p		
2N6247	190p		
2N6254	130p		
2N6290	65p		
2N6292	65p		
2SC1172	150p		
3N128	120p		
3N140	120p		
3N141	110p		
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2102-2L	120p	Z80-S10-1	£24
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2111-4	400p		
2112-4	300p	**UART**	
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4027-3	375p	IM6402	500p
4044	900p	TMS6011NC	400p
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5101	510p	**CHARACTER GENERATORS**	
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74S201	350p	RO-3-2513 U.C	600p
82516	325p	RO-3-2513 L.C	700p
ROM/PROMs		SN74S262AN	£10
71301	700p		
74S188	225p	**KEYBOARD ENCODER**	
74S387	350p	AY-5-2376	700p
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74S471	650p	**CRYSTALS**	
74S571	650p	32.768KHz	250p
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1600	1200p	200KHz	370p
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2650A	2000p	1.008MHz	350p
6502	700p	1.8432MHz	325p
6800	650p	2.00MHz	325p
6802	950p	2.45760MHz	325p
6809	2500p	3.276MHz	300p
8080A	450p	3.579MHz	175p
8085A	1100p	4.00MHz	290p
1NS8060	1000p	4.194MHz	POA
Z80	750p	4.43MHz	125p
Z80A	950p	5.0MHz	325p
EPROMS		6.0MHz	300p
1702A	500p	6.144MHz	300p
2708	450p	7.0MHz	300p
2716 (+5V)	£7	7.168MHz	300p
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6532	900p	12.0MHz	350p
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6821	340p	18.00MHz	300p
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8259	950p		
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Z80810-1	£24		

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BYX36-300	20p	1N916	7p
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For TO5 12p

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1A 400V	90p	BT106	110p
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3A 600V	140p	MCR101	36p
12A 400V	160p	TIC44	27p
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DPDT	70p
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Programming service for 2716 available by appointment or by mail.

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EXP600 6 x 2.4 (Up to 1 x 40 pin DCs)	£6.30

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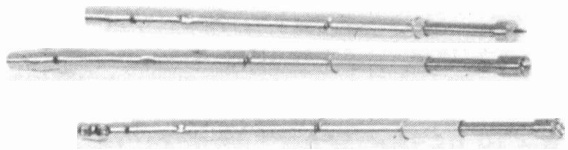
Keep Your Pecker Up

Chiptech have just introduced a new portable EPROM programmer based on the Z80 microprocessor. The PKW5000 is capable of programming devices up to 32K bits, including the 2708, 2716, 2732, 2516 and 2532 EPROMs. Keyboard function commands such as load, write, erase, check, compare and buffer clear as well as data entry and various editing functions through the RAM buffer are available.

A 16 digit hex display shows address and data information and also the EPROM type selected. An audible warning confirms the key-in operation, programming completion and error occurrence.

In addition to its programming capability, the PKW5000 may be used to run and debug Z80 programs with readout of all registers and insertion of up to two breakpoints. An optional I/O card will allow the unit to be interfaced with a 150 CPS tape reader, a 20 mA current loop or RS232C serial interface. The option also contains sockets which can accept preprogrammed EPROMs containing an assembler, debug program or BASIC.

For further information on the PKW5000 get in touch with Chiptech Ltd, Unit One, Tewin Court, Welwyn Garden City, Hertfordshire AL7 1AU.



Test Points

Vero Electronics can now supply a range of high quality, low cost probe pins for testing bare or component-loaded boards, wire-wrap boards or backplanes.

The pins come in two parts — the receptacle, which is available in either minwrap or solder termination, and the spring contact, which can have any one of three tips. The serrated tip will cut into flat pads to enable readings to be taken; the conetip can be used to probe plated-through holes; the cup can be used for wire wrap boards or backplanes.

The pin constituents are a veritable tour of the periodic table. The spring contact probes have heat treated beryllium copper plungers plated with rhodium over nickel and the phosphor bronze receptacles and nickel silver contact shells are plated with gold over nickel.

For further details of these low cost probe pins contact Vero Electronics Ltd, Industrial Estate, Chandlers Ford, Eastleigh, Hampshire SO5 3ZR.

APOLOGY

On page 84 of the September issue of Electronics Today International we published an advertisement placed by Tempus which stated that Zeon had gone into voluntary liquidation. This statement referred to Zeon Products Limited and was not intended to reflect in any way on Zeon Limited.

The advertisement was phrased in such a way that it may have been detrimental to Zeon watches. No criticism of the watches sold by Zeon Limited under the "Zeon" trade mark was intended. Furthermore, we are informed that Zeon Limited have taken over the service obligations entered into by Zeon Products Limited, thereby providing continuing service.

We wish to apologise to Zeon Limited for any embarrassment which the advertisement may have caused.

Microbasics

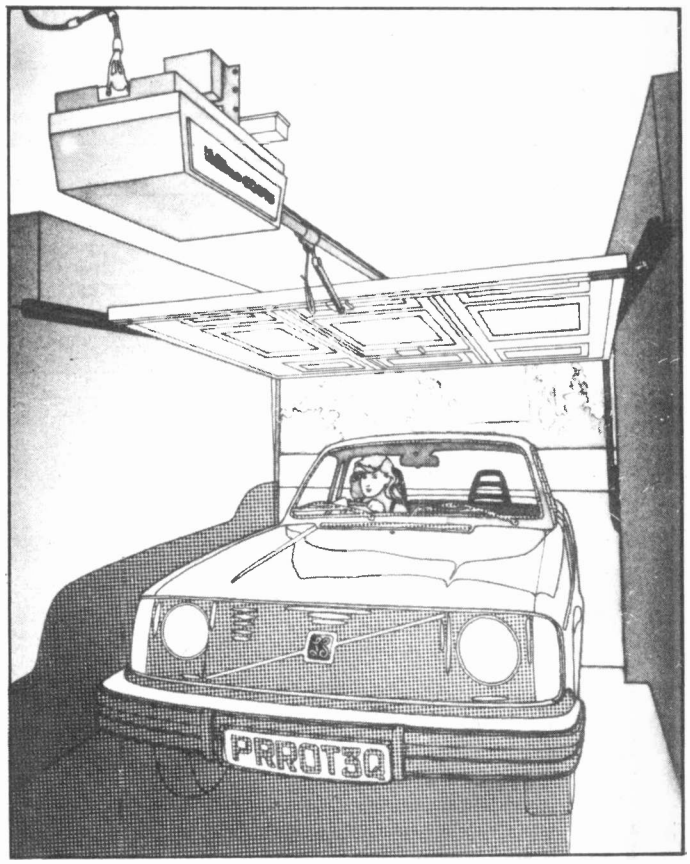
We've had a few inquiries about the subject of the photo we used to start off Microbasics in September. It was one of the first all-transistor computers, built at Harwell between 1952 and 1954. In the 1950s, CADET (the reversed initials of Transistor Electronic Digital Automatic Computer) was thought of as a mini compared to the vast valve complexes of the day.

CADET was used for several years at Harwell. The UK nuclear programme and Harwell's involvement generally in electronics and instrumentation benefitted from the experience gained from the design, construction and use of CADET. You may have seen some of its original circuit panels at the 'Challenge of the Chip' exhibition at the Science Museum in London.

Home Computing

A new computerised garage door which has achieved great success in the States, is now being sold in the UK. It is being introduced to builders' merchants, hardware, electrical DIY and car accessory retailers. The NuTone garage door operates from the greater than normal distance of 400 yards, has a computer that makes its own adjustments and is simple to instal. Whilst it is a convenience to the ordinary motorist it is also useful for elderly or handicapped drivers. The hand-held radio control unit is fitted with British-made electronics and is Home Office approved. Additional units can be purchased as well as an alternative key-operated opening device which can be fitted to the gatepost or a site convenient to the garage entrance. Inside the home a push button switch (this is included) can be installed to operate the NuTone door.

A built-in light is also included to switch on once the door is opened. Should the door be obstructed as it tries to close, the motor will automatically reverse until the door is fully open. In the event of an obstruction as it opens, the motor will stop. The garage door operator costs £229 including VAT. The radio receiver, transmitter and aerial costs £75; the key switch system £9.25; a manual release button £14.85; additional transmitters £28.25 and pushbuttons 85p. A Haos service agent will confirm whether or not a garage door can accommodate the unit. The Haos Company Ltd are at The Built-In Centre, 32 Letchworth Drive, Bromley, Kent.



New Records

Digital recording techniques are taking off in a big way at EMI's Abbey Road studios in London. The result of a four year R&D programme is EMI's first digitally recorded classical album — Debussy's 'Images' played by the London Symphony Orchestra conducted by André Previn. This has won three major awards since its release in December 1979.

EMI has been using five SE7000M units for its experimental recordings, which were primarily designed for laboratory standard scientific and engineering instrumentation and data recording applications. They were selected for use by EMI for their high quality performance and ability to withstand rigorous use. The advantages of digital recording are that it provides audio engineers with the ability to eliminate all extraneous background noise and distortion problems associated with conventional recording techniques.

Analogue recording is susceptible to equipment noise and non-linear recording characteristics as well as many other factors. Digital recording gives the ability to store and subsequently edit signals so that the sound remains distortion-free throughout the various production processes. The resultant sound has far greater clarity and freshness.

Each of the recording systems being used at Abbey Road comprises a single encoder and decoding unit interfaced to an SE7000M recorder. The complete system is trolley mounted to facilitate movement around the studios and for location work. At Abbey Road they can be moved to various locations within the building,although they will mainly be used in the larger Studio One for orchestral productions. However,they are also required for location work in Europe and America and have been shipped for recording sessions as far apart as Berlin, Philadelphia, Vienna and Amsterdam.

All material is recorded on standard 10½" reels of 1" magnetic tape running at 30 inches per second. Currently only two channels of sound can be processed digitally, using two tracks per channel to store data at the very high density level of 25 k/bits per inch. The outstanding quality of recordings is achieved due to this and an extremely sophisticated error-correction system to counteract drop-out or blemishes on the tape. For recording sessions, two digital systems are normally used together to provide a back-up facility. At Abbey Road they can interface with the mixing consoles in any of the three studios.

At present, editing of the digital material is carried out on the computer-controlled prototype equipment at the Central Research Laboratories. This function will soon be undertaken at Abbey Road itself.

By the end of 1980 virtually every classical record produced at Abbey Road will be digitally recorded. 'Middle of the road' and 'pop' discs generally rely on multi-track facilities, but even these can be produced using a mixture of analogue and digital recording processes. The final product will still offer improved reproduction quality.

Sound and Vision

Thorn Television Rentals and Magnetic Video, a subsidiary of 20th Century Fox, have reached an agreement in which Thorn will market through its TV rental outlets VHS video cassettes of 43 film titles. The range includes 'Butch Cassidy and the Sundance Kid', 'The Poseidon Adventure', 'Cleopatra', 'M.A.S.H', 'Patton', 'The Sound of Music', 'The French Connection', 'Hello Dolly', 'Gentlemen Prefer Blondes', 'Soldier Blue' and 'Von Ryan's Express'. Initially they will be available on a test market basis through rental showrooms and later in the year through all 1,200 outlets of the Thorn Rental Group. This will be the first time that major film titles will be available on a rental basis to the general public. Rates will be £5 for hire over three days.

EMPerative

If you wish to protect your telecommunications equipment or other information transmission system from the effects of EMP, the M-O Valve Co. has something for you. They have introduced a fast acting gas-filled surge arrestor, type E3465. Conventional gas-filled surge arrestors designed for lightning protection do not give adequate protection against EMP. The E3465 is a sub-miniature metal ceramic device which, when used in conjunction with a suitable holder can provide protection on a nanosecond time scale. It has a maximum surge strike voltage of 1 kV at 1 kV/nS rate of rise and a maximum capacitance of 4 pF, whilst retaining the normal advantages of gas-filled arrestors of high current capability and low discharge voltage. For further information contact the M-O Valve Co, Brook Green Works, London W6.

For further news of ETI's pursuit of the EMP phenomenon turn to page 15!

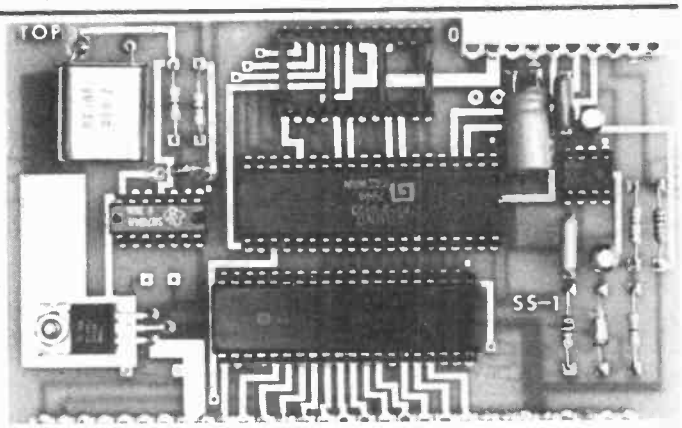
Sounding Board

Sirius Cybernetics can now supply a programmable sound synthesiser board for the SWTPC S50 bus 6800 and 6809 computers. For £60 (including post, but excluding VAT) you get an assembled and tested slot printed circuit board and driving software.

The package enables the 16 internal registers of the sound synthesiser chip to be programmed either from assembly language or BASIC. Three independently controlled sound channels producing a tone and white noise can generate a variety of sound effects or music.

Two bi-directional 8-bit ports are also provided on the board for, amongst other things, the connection of keyboard or games paddles to the host computer. The board even has its own on-board power amplifier. Just connect a loudspeaker.

The 6800/6809 S50 bus Sound Synthesiser board is available from Sirius Cybernetics Ltd, 7 Euston Place, Leamington Spa, Warwickshire CV32 4LN.



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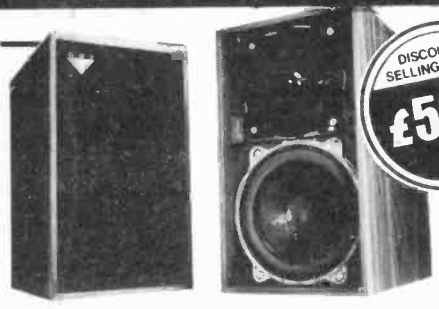

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A MESSAGE FROM VIDEOTONE

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E.T.I. 11/80

EMP

Following ETI's article on EMP, Tina Boylan has been finding out what's going on in the country to protect us in a nuclear war.

In the event of war our protection will depend mainly on local councils and this is the area that we have explored to find out exactly what is going on. Local councils will be in charge of re-organising the survivors in their area in the aftermath of a nuclear strike. This will basically mean local groups providing food, medical help and checking damage. As far as their radio communications are concerned, equipment at this local level has no special, built-in protection against EMP other than those in the Home Office's standard specification. How effective this will be is something no-one really seems to know.

The only other protection this equipment will have is either that at the 'four minute warning' the radios will be switched off at the mains and have their aerials removed, or that a back-up system will remain 'frozen' until the danger of EMP has passed. Standard procedure will then be followed. After 24 hours the equipment will be switched on again and broadcasts will be tried on frequencies 1-10 (is there anybody out there?); after 36 hours frequencies 10-20 will be tried, etc, until either something is located or until someone realises that the equipment is useless. In the meantime, according to one man "there'll be a lot of telephoning around". Perhaps someone forgot to tell him that EMP will almost certainly destroy *all* telephone communications!

This method of 'protection' of equipment relies heavily on the assumption that 1) there *will be* a four minute warning and, 2) that the enemy hasn't made a nuclear detonation over somewhere like the North Sea, which will knock out these communications anyway.

Us and Them

Strangely enough, local as well as national Government has known about the EMP effect for between four and six years, since its discovery during nuclear tests in the Pacific, but they have not considered it to be of interest to the general public. With this long-standing knowledge perhaps something more tangible should have been done, but again, it's the same old story; finance — or rather lack of it — has prevented much action being taken.

Until recently, civil defence in general has not appeared on the local council list of priorities. But since the Afghanistan crisis reared its ugly head, a more careful study of the country's state of readiness for war has been made. The results of this investigation prompted Mr. Whitelaw, the Home Secretary to make a statement in the House of Commons on August 7th this year. There is a firm belief that any war is likely to start conventionally and escalate into nuclear exchange.

The main points of Mr Whitelaw's speech were that the UK monitoring and warning organisations would modernise their equipment and that the associated communications network responsible for wartime broadcasting would be improved, so that it can continue public broadcasting even after a large scale attack.

As far as local defence plans are concerned he had this to say:

"A great deal of civil defence work must be done at local level, and the Government propose to double the money available for this purpose. We shall consult the local authority associations about the allocation of additional resources for planning and training, and the adaptation of premises by district councils to complete the pattern of local authority wartime administrative headquarters and communications. Effective civil defence arrangements depend upon co-operation between central Government and local government. I know that concern has been expressed about variations in civil defence arrangements in different parts of the country. I am satisfied that the Government have adequate powers to ensure that proper standards of protection are provided throughout the country, and it will naturally be our aim, with the local authorities, to see that this is done."

Cut-Backs

It is understood that by 1984 civil defence spending will have risen by 60%. This additional cost will be covered by "re-allocation of resources within existing programmes without adding to the total of public expenditure". This means that local government will have to find the money out of their existing budgets, already tightly squeezed by cut-backs. In one county at least, civil defence was described 'second to bottom on the list of priorities'. So even if there is extra cash allocated to it, there are no plans at present for further expenditure on communications in particular. The main priorities are to improve training of volunteers and if possible choose various leading members of the community to help with reorganisation after the holocaust. The concensus of opinion is that if nuclear war, as opposed to conventional war, breaks out, there is little that can be done to prevent huge numbers of casualties. The only course of action therefore, that local government can (reasonably) take is to provide a well trained reorganisation force to help the survivors. However, as one spokesman said, and this must be ETI's quote of the month, "after all, life goes on, you know". I somehow think *he* won't be standing at ground zero!

So it seems to be largely up to the public themselves to find out what should be going on, then try to do something about it. The 'men from the ministry' whom I contacted, seemed rather upset that the great British malaise is apathy. It generally takes two forms. Firstly, that we believe we will be looked after completely by the Government, something similar to what happened during the Second World War with plenty of shelters and ARP/Home Guard types. Secondly, there is the pacifist attitude that "honour will prevail" and common sense and negotiation will prevent war.

After the Afghanistan crisis the local authorities were bombarded with telephone calls from people either willing to offer their services or simply wanting to find out how to protect themselves. If you want to find out who is in charge of your local defence plans, simply telephone the Home Office in London on 01-213 3000. They were able to supply us with the names, addresses and telephone numbers of all civil defence organisations, or you can contact your local council. For 50 pence you can also obtain the government leaflet 'Protect and Survive' which certainly prompted us to ask a few questions! Keep sending the letters.

ETI

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00	KB4413	1.95
L200	1.95	KB4417	1.80
U237B	1.28	TDA4420	2.25
U247B	1.28	KB4420B	1.09
U257B	1.28	KB4423	2.30
U267B	1.28	KB4424	1.65
LM301H	0.65	KB4431	1.95
LM301N	0.38	KB4432	1.95
LM308H	0.90	KB4433	1.52
LM308N	0.65	KB4436	2.53
LM339N	0.65	KB4437	1.75
LM348N	1.85	KB4438	2.22
LF351N	0.88	KB4441	1.35
LF353N	0.76	KB4445	1.29
LM374N	3.75	KB4446	2.75
LM380N-14	1.00	KB4448	1.65
LM380N-8	1.00	NE5044N	2.26
LM381N	1.81	NE5532N	1.85
ZN419CE	4.95	SD6000	3.75
NE544N	1.80	SL6270	2.03
NE555N	0.30	SL6310	2.03
NE556N	0.50	SL6600	3.75
NE560N	3.50	SL6640	2.75
NE562N	4.05	SL6690	3.20
NE564N	4.29	SL6700	2.35
NE565N	1.00	ICL8038CC	4.50
NE566N	1.60	MSL9362	1.75
NE570N	3.85	MSL9363	1.75
SL624	3.28	HA11211	1.95
TBA651	1.81	HA11223	2.15
uA709HC	0.64	HA11225	1.45
uA709PC	0.36	HA12002	1.45
uA710HC	0.65	HA12017	0.80
uA710PC	0.59	HA12402	1.95
uA741CH	0.66	HA12411	1.20
uA741CN	0.27	HA12412	1.55
uA747CN	0.70	LF13741	0.33
uA748CN	0.36	SN76660N	0.80
uA753	2.44		
uA758	2.35		
TBA810AS	1.09		
TBA820M	0.75		
TCA940E	1.80		
TDA1028	2.11		
TDA1029	2.11		
TDA1054	1.45		
TDA1062	1.95		
TDA1072	2.69		
TDA1074A	5.04		
TDA1083	1.95		
TDA1090	3.05		
HA1137	1.20		
HA1196	2.00		
HA1197	1.00		
TDA1220	1.40		
LM1303	0.99		
LM1307	1.55		
MC1310P	1.90		
MC1330	1.20		
MC1350	1.20		
HA1870	1.90		
HA1388	2.75		
TDA1490	1.86		
MC1496P	1.25		
SL1610P	1.60		
SL1611P	1.60		
SL1612P	1.60		
SL1613P	1.89		
SL1620P	2.17		
SL1621P	2.17		
SL1623P	2.24		
SL624C	3.28		
SL1625P	2.17		
SL1626P	2.44		
SL1630P	1.62		
SL1640P	1.89		
SL1641P	1.89		
TDA2002	1.25		
TDA2020	3.00		
ULN2242A	3.05		
ULN2283B	1.00		
CA3080E	0.70		
CA3089E	1.84		
CA3090AQ	3.35		
CA3123E	1.40		
CA3130E	0.80		
CA3130T	0.90		
CA3140E	0.46		
CA3189E	2.20		
MC3357P	2.35		
LM3900N	0.60		
LM3909N	0.68		
LM3914N	2.80		
LM3915N	2.80		
KB4400	0.80		
KB4406	0.60		
KB4412	1.95		

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MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
ICM7106CP	9.55
ICM7107CP	9.55
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ICM7217A	9.50
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4011B	0.20
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4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

7400N	0.13	7443N	1.15	74LS112	0.38
74LS00	0.20	7444N	1.12	74LS113	0.38
7401N	0.13	7445N	0.94	74LS114	0.38
74LS01	0.20	7446N	0.94	74118N	0.83
7402N	0.14	74LS47	0.89	74120N	1.15
74LS02	0.20	7448N	0.56	74121N	0.42
7403N	0.14	74LS48	0.99	74122N	0.46
74LS03	0.20	74LS49	0.99	74123N	0.73
7404N	0.14	7451N	0.17	74LS124	1.75
74LS04	0.24	74LS51	0.24	74125N	0.38
7405N	0.18	7453N	0.17	74LS125	0.44
74LS05	0.26	74LS54	0.24	74126N	0.57
7406N	0.28	74LS55	0.24	74LS126	0.44
7407N	0.38	7460N	0.17	74128N	0.74
7408N	0.17	74LS63	1.24	74132N	0.73
74LS08	0.24	7470N	0.28	74LS132	0.78
7409N	0.17	7472N	0.28	74LS136	0.40
74LS09	0.24	7473N	0.32	74LS138	0.60
7410N	0.15	74LS73	0.38	74141N	0.56
74LS10	0.24	7474N	0.27	74142N	2.65
7411N	0.20	74LS74	0.28	74143N	3.12
74LS11	0.24	7475N	0.38	74144N	3.12
7412N	0.17	7476N	0.37	74LS145	0.97
7413N	0.30	74LS76	0.38	74147N	1.75
7414N	0.51	74LS78	0.38	74148N	1.09
74LS15	0.24	7480N	0.48	74LS148	1.19
7416N	0.30	7481N	0.86	74150N	0.99
7417N	0.30	7482N	0.69	74151N	0.55
7420N	0.16	7485N	1.04	74LS151	0.84
74LS20	0.24	74LS85	0.99	74153N	0.64
7421N	0.29	74LS86	0.40	74LS153	0.54
74LS21	0.24	7489N	2.05	74154N	0.96
7423N	0.27	7490N	0.33	74155N	0.54
7425N	0.27	74LS90	0.90	74LS155	1.10
7427N	0.27	7491N	0.76	74156N	0.80
74LS27	0.44	74LS91	1.10	74157N	0.67
7428N	0.35	7492N	0.38	74LS157	0.55
74LS28	0.32	74LS92	0.78	74LS158	0.60
7430N	0.17	7493N	0.32	74159N	2.10
74LS30	0.24	74LS93	0.99	74160N	0.82
7432N	0.25	7494N	0.78	74LS160	1.30
74LS32	0.24	7495N	0.65	74161N	0.92
7437N	0.40	74LS95	1.14	74LS161	0.78
7438N	0.33	7496N	0.58	74LS162	1.30
74LS38	0.24	74LS96	1.20	74163N	0.92
7440N	0.17	7497N	1.85	74LS163	0.78
74LS40	0.24	74LS107	0.38	74164N	1.04
7441N	0.74	74109N	0.63	74LS164	1.30
7442N	0.70	74LS109	0.70	74165N	1.05
74LS42	0.99	74110N	0.54	74LS165	1.04
		74111N	0.68	74167N	2.50

74LS169	2.00
74170N	2.30
74LS170	2.00
74LS174	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74LS193	1.80
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
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BA379	0.35
TDA1061	0.95

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1N4001	0.06
1N4002	0.07
1N5402	0.15
OA91	0.07
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3rd OT 30pF HC25U	1.65
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Pairs AM	3.10

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32.768 kHz	2.70
100kHz	3.85
455kHz	5.00
1.0MHz	3.00
3.2768MHz	2.70
4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

5MM RED	0.12
3MM RED CLEAR	0.15
3MM RED	0.15
2.5 X 5MM RED	0.17
5MM GREEN	0.15
3MM GN CLEAR	0.16
3MM GREEN	0.16
2.5 X 5MM GN	0.20
5MM YELLOW	0.15
3MM YELLOW CL	0.16
3MM YELLOW	0.18
2.5 X 5MM YE	0.20
5MM ORANGERED	0.20
5MM ORA CL	0.29
3MM ORANGERED	0.19
2.5 X 5MM ORA	0.24
5MM INFRA RED	0.56
BPW41 IR DET	1.51
IR OPT CPLR	1.44
5MM CLIP	0.04

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3.5 digit	9.45
4 digit	8.95
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BC239	0.08
BC307	0.08
BC308	0.08
BC309	0.08
BC413	0.10
BC414	0.11
BC415	0.07
BC416	0.08
BC546	0.12
BC556	0.12
BC550	0.12
BC560	0.12
BC639	0.22
BC640	0.23
2SC1775	0.18
2SA872A	0.14
2SD666A	0.30
2SB646A	0.30
2SD668A	0.40
2SB648A	0.40
2SD760	0.45
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2SC2546	0.19
2SA1084	0.20
2SC2547	0.19
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2SB723	2.34
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2SK135	3.75
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BD535	0.52
BD536	0.52
BD377	0.33
BD378	0.33
BD165	0.30
BD166	0.31

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BF224	0.22
BF241	0.18
BF274	0.18
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BF441	0.21
BF362	0.49
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BF479	0.66
BF679S	0.55
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BFW92	0.60
BFT95	0.99
BFY90	0.90
40238	0.85

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2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
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BF960	1.24
3SK48	1.64

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CM161. Miniature clock, 12/24 hr., alarm, day, date, backlight. All for.....9.95

CAPACITORS

All 5mm or less spacing

CERAMIC 50v
2P2, 3P3, 4P7, 6P8
8P2, 10P, 15P, 18P..0.04
22P, 27P, 33P, 47P
56P, 68P, 82P, 100P..0.05
150P, 220P, 270P
330P, 390P, 470P...0.055
1N0, 2N2, 3N3, 4N7..0.06
10N (0.01uF)....0.05
22N, 47N.....0.06
100N, 220N.....0.09

MONOLITHIC CERAMIC
10N, 100N.....0.16

FEEDTHRU
1N0 SOLDER IN....0.09

POLYESTER (SIEMENS)
10mm LEAD SPACING
10N, 22N, 33N.....0.17
47N, 68N, 100N.....0.19
220N, 470N.....0.22
1uF.....0.29

POLYESTER (GENERAL)
10mm LEAD SPACING
10N, 15N, 22N, 33N..0.06
47N, 68N, 100N.....0.08
220N.....0.11
20mm LEAD SPACING
220N, 330N, 470N...0.18

MYLAR
5mm LEAD SPACING
1N0, 10N, 22N, 33N..0.08
100N.....0.09
20mm LEAD SPACING
220N, 470N..... 0.17

POLYSTYRENE
10P, 15P, 18P, 22P,
27P, 47P, 56P, 68P..0.08
100P, 180P, 220P,
270P, 330P, 390P...0.09
470P, 680P, 820P...0.10
1N0, 1N2, 1N5, 1N8..0.11
2N2, 2N7, 3N3, 3N9..0.12
4N7, 5N6, 6N8, 10N..0.13

TANTALUM BEAD CAPS
16v: 0.22, 0.33,
0.68, 1.0.....0.18
16v: 2.2, 4.7, 10..0.19
6v3: 22, 47.....0.30
10v: 22, 100.....0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

(uF/voltage)
1/63, 2.2/50, 4.7/35
10/16, 15/16, 22/10
33/6.3.....0.08
22/16, 33/10,
47/10.....0.09
10/63, 22/50, 33/50,
47/16, 100/16.....0.10
47/63, 100/25, 220/16
470/6.3.....0.12
100/63, 470/16,
1000/10.....0.18
1000/16, 470/63...0.23
1000/63, 2200/16..0.30
3300/25.....0.69
1000/100.....0.88
10000/70.....3.00

AXIAL (HORIZ. MOUNT)
1/25, 4.7/16, 6.4/25
10/16.....0.08
4.7/63, 22/10, 22/16
33/16.....0.09
47/25, 100/16.....0.10
100/25.....0.11
1000/16.....0.25
2200/16, 1000/25..0.36
1000/35, 4700/16..0.45
1000/50.....0.58

RESISTORS

0.25W, 5% E12 CARBON
1ohm-10M.....0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M.....0.05

HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5.....0.12

HORIZ CERMET PRESETS
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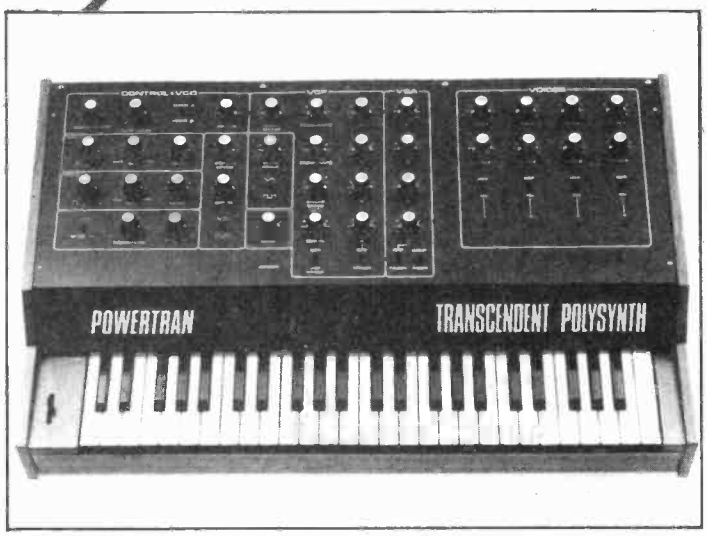

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Transcendent, a name familiar to ETI readers, turns up next month in the shape of our latest keyboard instrument project. The Transcendent Polysynth, designed by Tim Orr, is a polyphonic music synthesiser. It can be operated with one, two, four and even eight voices. Each voice is a synthesiser in itself, containing two VCOs, two ADSR units, one VCA and one VCF. The design features all the usual synthesiser functions — pitch bend, portamento, noise source, modulation oscillators, etc.

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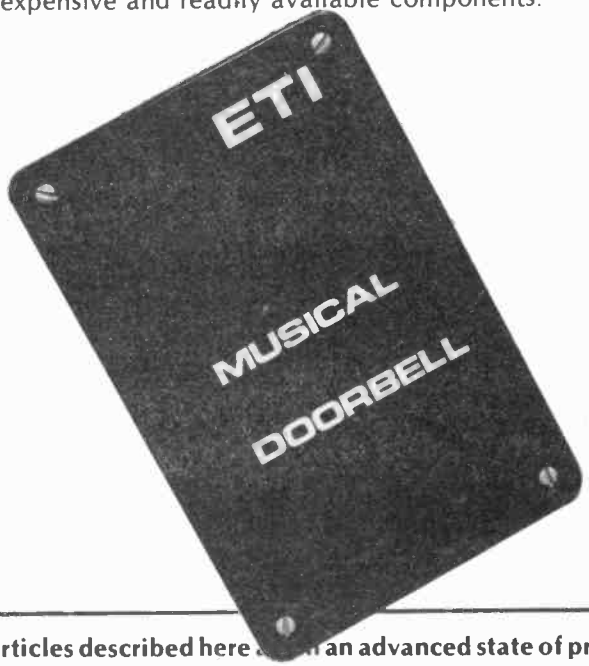

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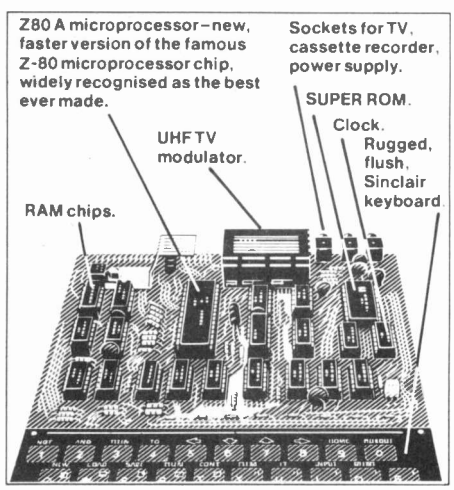

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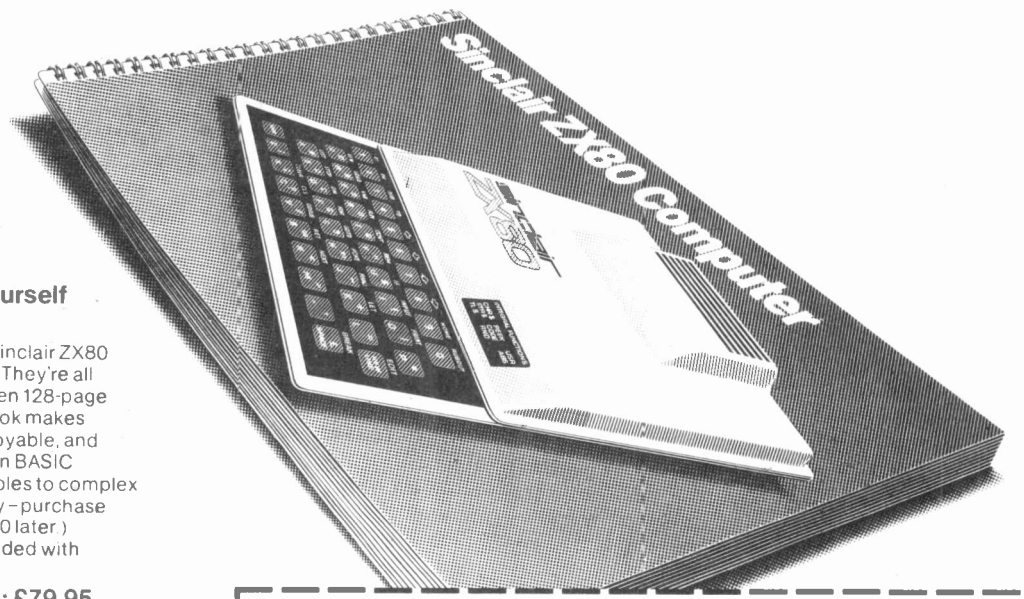

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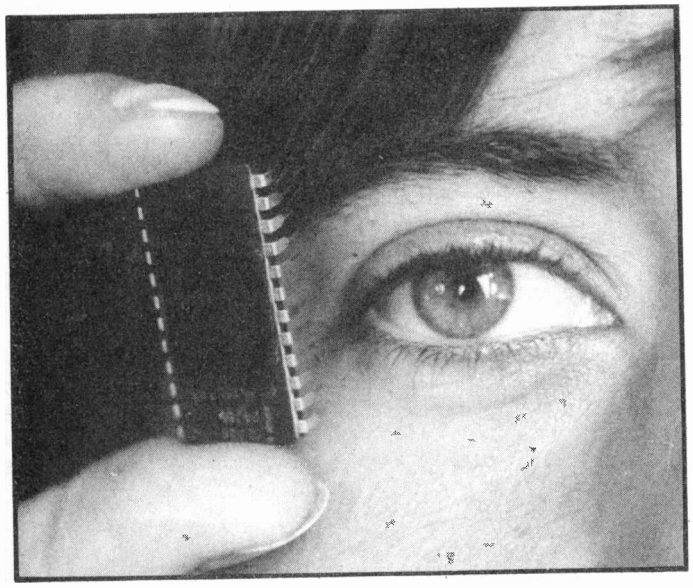
MICROBASICS

Remember, remember ETI November. Henry Budgett explains how microprocessors ROaM round the RAM chips. It's all a question of memory.



It is doubtful if even the legendary skills of the elephant could cope with the vast and bewildering array of memory devices that are currently offered with each and every microprocessor. Would you choose dynamic or static; is there any difference between on-line and off-line storage; do bubbles really bubble and many other similar questions often crop up in reader's enquiries and only go to show that the fundamental topic of computer storage is in dire need of a bit of explanation. To that end let's go right back to the fundamentals and take it from there.

The Elemental Store

Computers of digital type work on the binary system — they process information that occupies one of two states. The commonest logical element that can occupy one of two states is the bistable and, in simple terms, all computer memory can be regarded as constructed of simple bistable elements. We need not concern ourselves with the history of memory devices (it will only serve to confuse the issue), so let's start off with semiconductor devices such as Random Access Memory and Read Only Memory, RAM and ROM to use the common acronyms.

In virtually all computer designs RAM is the fundamental storage system for the user to put his instructions into. Within this family of circuits there are two sub-groups, static and dynamic, but the simplest element is the common bistable. Static RAM is really a vast number of bistables arranged in a special fashion. Some popular arrangements are 1024 by 1, 2048 by 1, 1024 by 4 and many, many others. The numbers specify the way the device is used, for example if you wish to construct a memory card that could hold 1K bytes of program you would need eight of the first kind of chip or two of the third kind.

Amnesia

Because these static elements are based on simple logic gates, they will lose their contents when turned off, just as any logic will, but they do have a number of advantages. Once the desired information has been loaded into the memory (more on that later) it will stay there until either it is altered or someone turns the computer off. The disadvantage of this is that it requires the power to be constantly maintained within the chip and thus the current consumption of these devices is high. You do get a good, high-speed response in exchange, though. It is common to find that within the structure of a single microcomputer both static and dynamic RAM devices are used, with the static providing the workspace or 'scratchpad' area for the CPU and the dynamic providing the bulk user RAM and hence saving power.

The fundamental difference between dynamic and static devices is that dynamic devices will lose the stored information if they are not 'refreshed' every so often. The reason for this is that they are based on MOS technology and store the information on tiny capacitors as a charge. This charge will leak away after a finite time and thus has to be constantly topped up. This process

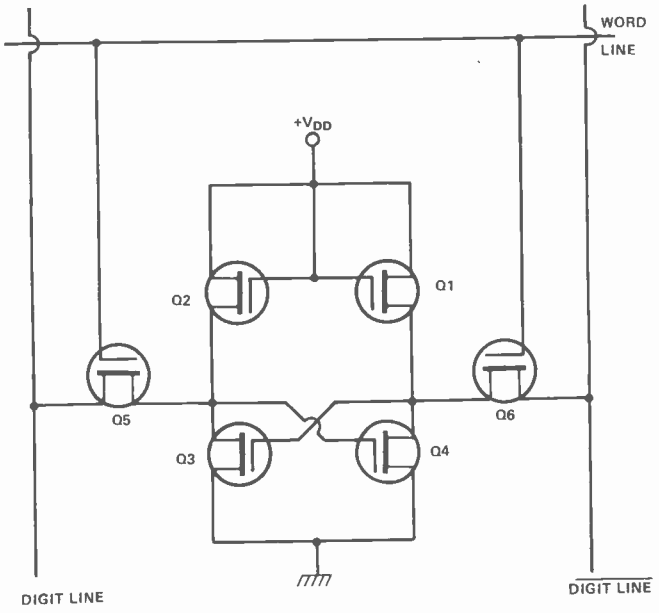


Fig.1 MOS static memory cell.

can either be performed within the chip or by some special circuitry on the memory board or, in the case of the Z80 CPU, by the micro itself. Typical refresh times are between 1 and 2 mS and woe betide the designer who tries to cut it fine because increases in temperature have very undesirable effects that compound the problem.

In summary, therefore, RAM is used by the micro as its immediate store and is based around the humble bistable type of logic element. In strong contrast we have the ROM memories which as their name implies, can only be read and hence are used as permanent stores.

Memories Are Made Of This

It is worth taking a few minutes to inspect the internal architecture of both static and dynamic devices at the storage element level. Figure 1 shows the equivalent circuit for a static MOS memory cell. Transistors within the chip are all made as MOSFETs which, although slower than bipolar transistors, consume less power and hence allow greater packing densities. Q1 and Q2 are actually being used in this circuit as resistors to bias the bistable element made from Q3 and Q4. The transistors Q5 and 6 act as switching gates to allow information to be read or written to the cell. To read a cell the word line is set to logic one which will turn on either Q5 or Q6 depending on the contents of the cell. To write the word line is again set to logic one but the appropriate digit line is set so that the cell contents are toggled to the correct value.

The dynamic MOS element shown in Fig. 2 uses the technique of stored charge to represent information. To write new information to the cell the row line is set to logic one and the appropriate data is set onto the data line. Reading the cell is performed by setting the row select high and inspecting the state of the data line.

A Family Affair

If you thought that having two types of RAM was quite enough to cope with then ROM will try your mental processes even more. The original ROMs are truly Read Only in that the user buys them pre-programmed to a specification and there is no way that he can alter the contents. Computer monitor programs are commonly based in ROM, but with the high cost of producing the original 'mask', (that's the pattern to which they are made), several companies are turning to other devices such as the EPROM. The internal arrangement of a ROM chip is not dissimilar to that of a RAM chip except that each and every element is 'hard wired' to either logic '1' or logic '0'. It would obviously be nice if the user could program in his own pattern and try it out and to this end the PROM device emerged. This is a ROM with each element uncommitted, but with a tiny piece of 'fuse wire' called a fusible link fitted to each element. If you wish to select that as a logic '0' you leave it as it is, if you want it to be a logic '1' then you have to 'blow' the fuse, usually with a high voltage pulse.

All very well but once you've cooked it you're stuck with it, or are you? The designers found that if you didn't burn the link away thoroughly enough it started to grow back, embarrassing! This gave rise to the EAROM or Electrically Alterable ROM which allows you to erase the content of the device and later re-program it. It also gave birth to the most common type of device, the EPROM or Erasable Programmable ROM, which uses a

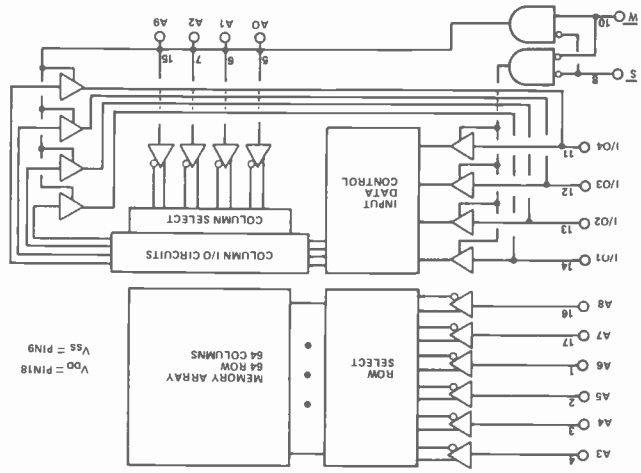


Fig.2 Dynamic memory cell.

slightly different internal structure and can be 'wiped' with ultraviolet light of a certain frequency — the contents of an EPROM will naturally self-erase after about one hundred years anyway!

The programming of these devices requires a special piece of equipment called, not surprisingly, a Programmer. These vary from the very crude to the amazingly sophisticated professional models that allow full program editing and verification and can handle many of the different types.

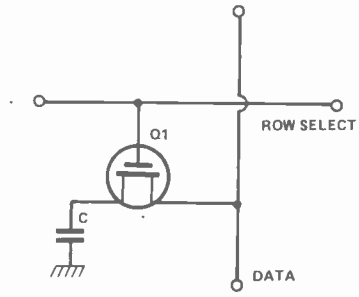


Fig.3 The internal layout of a 4096 bit static RAM device. Compare the architecture of this 1024 by 4 layout to that in Fig.4 of a dynamic 4096 bit device organised by 4096 by 1.

We can now introduce a new term which nicely classifies the two types of computer memory. RAM is called volatile memory; the contents 'evaporate' when the power is removed; ROM is non-volatile because it retains the information. Interestingly, the much-vaunted successor to RAM, the bubble memory device, is a non-volatile store, because it works on magnetism (much like the old-fashioned core memory).

Reads And Writes

Getting information into and out of memory devices is, generally, a straightforward process. With an eight bit microprocessor which has a 16 bit address bus the maximum amount of memory that you can directly address is 2^{16} or 65536 locations. Because we are working in binary and cannot have nice 'round' numbers this is referred to as 64K where one 'K' is 1024 locations. Each location contains eight bits of data, one byte, and can be uniquely addressed by the 16 address lines. The CPU determines whether the required access is a READ, taking information out of memory, or a WRITE, which puts information into memory by setting a control line to

→

either a logic one or a logic zero. This line is taken to all the memory devices and, appropriately gated, enables the required area of memory. Figures 3 and 4 show the internal structure of two typical devices.

Once the specified location has been opened, the data stored there is either transferred onto the data bus, in the READ situation, or is overwritten by the information on the data bus, the WRITE situation. It is important to note that the information is overwritten, so saving you the job of clearing out the previous contents.

There is a further control pin on many memory devices called Chip Select. This is set to either logic one or zero (depending on the device) when that memory area is required for use and this prevents possible accidents such as overwriting data in another part of the memory to that which you actually wanted. How can this happen if you have a unique addressing system? In most small computers you only have a small area of memory on the actual CPU card, the actual memory cards hold the bulk of RAM and ROM. Because of this the address bus is not decoded into specific areas; the Microtan 65 is a good example. Now, when you are using

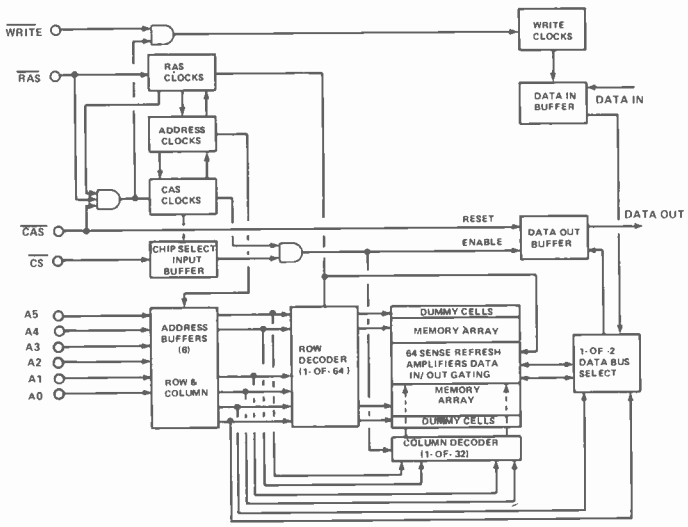


Fig.4 A 4096 bit dynamic RAM device. Compare with Fig.3.

only a small amount of memory you don't bother to decode all the addresses, you merely use, say, A15 to operate the Select on the monitor ROM, A14 to control the I/0 area and A13 to enable the RAM. This leads to repeating address inside the memory space, but this doesn't matter, because there are no devices physically occupying those actual locations. The trouble starts when you expand and forget to eliminate all these 'reflected' areas. The diagrams in Fig.5 and 6 show the case on the Microtan before and after memory mapping has been done and illustrates the problem admirably.

Dynamic Stuff

Because of the different technology used in the consideration of dynamic memory devices, allowing many more locations to be put onto one chip, one finds that, given a sixteen pin package, you don't have enough pins to supply all the necessary signals. This is solved by multiplexing the address bus and supplying the row address first and then the column address. The row address is stored internally, hence giving a complete matrix address and allowing the information to be accessed. The row address is also used to carry the refresh information during the correct cycle time.

The latest versions of dynamic RAM are being equipped with the capability of on-chip refresh. This means that to the outside world they look just like a static device, indeed they are sometimes called 'pseudo-static', and thus save all the problems of timing that are associated with the procedure.

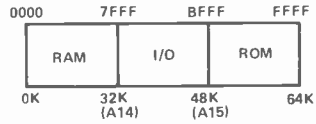


Fig.5 A simple memory map created by allowing the address lines A_{14} and A_{15} to select the appropriate memory areas. This causes the contents of the selected chip to be 'reflected' through the entire section of memory, but this does not matter provided that you only access the addresses which are connected to a device.

Banking On A Solution

In some situations 64K of memory is not enough, believe it or not. It is possible to access more by using a technique known as bank selecting. The required extra memory is treated as a peripheral device and accessed through the data bus, each extra board of memory occupying the same address area but having a unique code that selects it. The NASCOM 2 system is set up to allow up to four 48K RAM cards, that's nearly two hundred thousand bytes of memory to be plugged in. The technique does have another use in the field of Teletext and Prestel information. Here each page must be loaded into memory as it is received, with only 64K you'd soon run out. The technique is to allocate pages of memory to the received information and then to access that information from the paged memory as though it were a peripheral device.

One other technique that is very important, especially when you move into the realms of discs is that of Direct Memory Access (DMA). Because the time taken for the processor to read information from a fast peripheral such as a disc is slow, the disc controller takes command of the processor bus by asserting a control signal. The CPU goes into a high impedance stage, effectively it is disconnected, and the information is passed directly to the memory area specified.

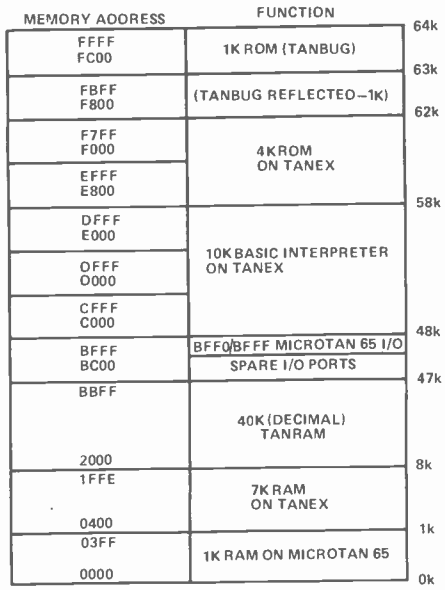


Fig.6 A typical system memory map showing the areas used by the system firmware and the spaces left for the user RAM.

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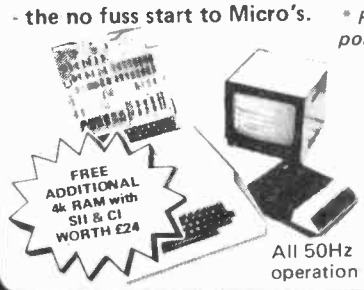

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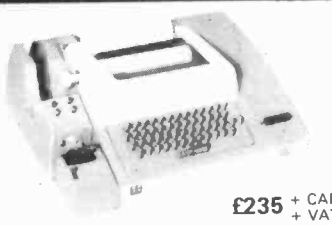

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computing today

What to look for in the November issue on sale October 10th.

We present the definitive article on just how all those graphics games make things move around. All the programs given are specially designed to allow their use as examples on any memory mapped system provided you know a couple of details. How do you find these details? Read our companion article of course.....

INTERACTIVE GRAPHICS

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CT starts an ongoing situation with a set of standard graphics maps for many popular machines together with vital details as to their screen layouts etc., so you can change games from system to system by looking up a simple code. Couldn't be easier, could it?

We present a general purpose plotting program for Apple owners. Display your functions using this powerful and adaptable piece of software. Owners of other systems that allow high resolution plotting such as the 380 Z might pick up a trick or two as well.

GRAPH PLOTTER

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As a companion to our series on interfacing techniques we present a high quality analogue to digital converter suitable for connection to any system with an eight bit parallel port. Sample programs for the PET are given along with full circuit and functional descriptions.

THE REAL WORLD

All articles mentioned herein are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

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3X011		9+9	4.44			
3X012		12+12	3.33			
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3X029		220	0.36			
3X030		240	0.33			
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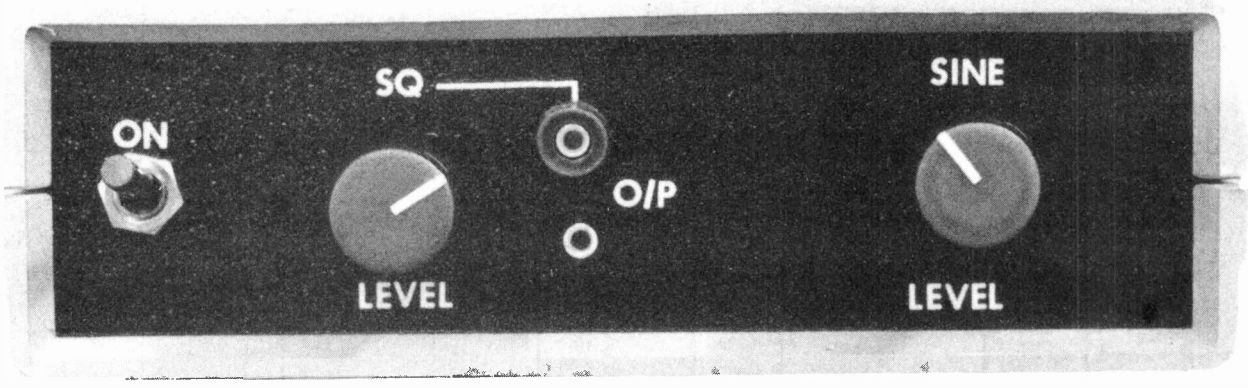
AUDIO OSCILLATOR

A testing time for ETI. This unit features sine and square outputs, from 30 Hz to 60 kHz, each with its own level control. Circuit design by Ray Marston. Project development by Steve Ramsahadeo.

Good quality sine/square generators, giving very low sine/wave distortion, are invaluable pieces of test gear but tend to be rather expensive. For the vast majority of practical applications, such as gain and frequency response testing, function checking and sound generation, etc, the expensive 'very low distortion' sine wave characteristic is, however, superfluous, since distortion factors up to several percent are quite acceptable in such applications.

With these points in mind, we've set out to design a really inexpensive and easily built, but genuinely useful, sine/square generator. Our generator covers the frequency range 30 Hz to 60 kHz in three switch-selected bands. Sine and square outputs are simultaneously available, each with their own independent level controls.

Automatic sine wave amplitude regulation is achieved in the circuit via a pair of back-to-back zeners in a control loop. This method of regulation is very inexpensive but has the great advantage of enabling range-sweeping to be achieved without amplitude bounce. Sine wave output distortion is typically less than 5% over most of the frequency range.



Construction

The circuit is very simple and construction should present few problems. We decided to construct our prototype unit as a miniature 'squirt box', with an uncalibrated frequency dial. If you decide to follow our method of construction, note that we have fitted the two frequency controls (RV1 and SW1) and the sine wave output terminals to the front panel of our unit and all remaining controls (RV3, RV4 and SW2) and the square wave output terminals to the instrument rear panel. Our unit is powered by two PP3 batteries.

Whatever form of construction you decide to use, note that timing capacitors C1-3 should all be 5% or better types and that RV1 should be a good quality stereo pot, with good tracking between its two halves. Failure to fit a good pot will result in a lousy sine wave output.

When construction is complete, switch the unit on, monitor the sine wave output on a 'scope and adjust RV2 to give the best possible output over the full operating range of the instrument. If you have any problems in obtaining top range oscillation, try altering the value of C4. When RV2 is correctly set, typical sine wave distortion will be less than 5% over most of the frequency range.

When using the generator, note that the '2 V' sine wave output terminal is intended for driving high impedance loads only. If this output is loaded by less than 10k or so the output will become severely distorted under maximum output conditions, due to the very limited drive capability of IC1. The '200 mV' and lower output ranges do not suffer from this loading restriction.

HOW IT WORKS

The heart of the unit is the Wien bridge oscillator designed around IC1. The Wien network comprises a series of C-R network (R1-RV1a and C1a/C2a/C3a) and a parallel C-R network (R2-RV1b and C1b/C2b/C3b) connected in series. Input signals are applied to the top of this network from the output of IC1 and the output of the network is applied to input pin 3 of IC1.

The main feature of the Wien network is that the phase relationship of its output to input signal varies from -90^{o} to $+90^{o}$ and equals zero only at a certain 'centre' frequency ($f = 1/6.28CR$). At this centre frequency the network is precisely symmetrical. Thus, the Wien network can be used as the basis of an oscillator by connecting a non-inverting amplifier with a gain equal to the Wien loss factor between its input and output, as in our design.

In our circuit, automatic gain control is obtained by wiring the ZD1-ZD2-RV2-R3-C4 gain-setting potential divider between the op-amp output and pin 2. When RV2 is correctly adjusted, this network maintains the output amplitude of the IC1 signal virtually constant (at about 2 V RMS) over the entire frequency range of the unit (30 Hz to 60 kHz) and results in a typical distortion factor of less than 5% on its sine wave output. The amplitude of the final sine wave output signal is variable via RV3 and the simple R4-R5-R6 attenuator network.

The direct sine wave output of IC1 is fed, via R7, to the input of IC2. This IC is wired as a simple voltage comparator and converts the sine wave input signal to a square wave output. The amplitude of the final square wave output is variable via RV4.

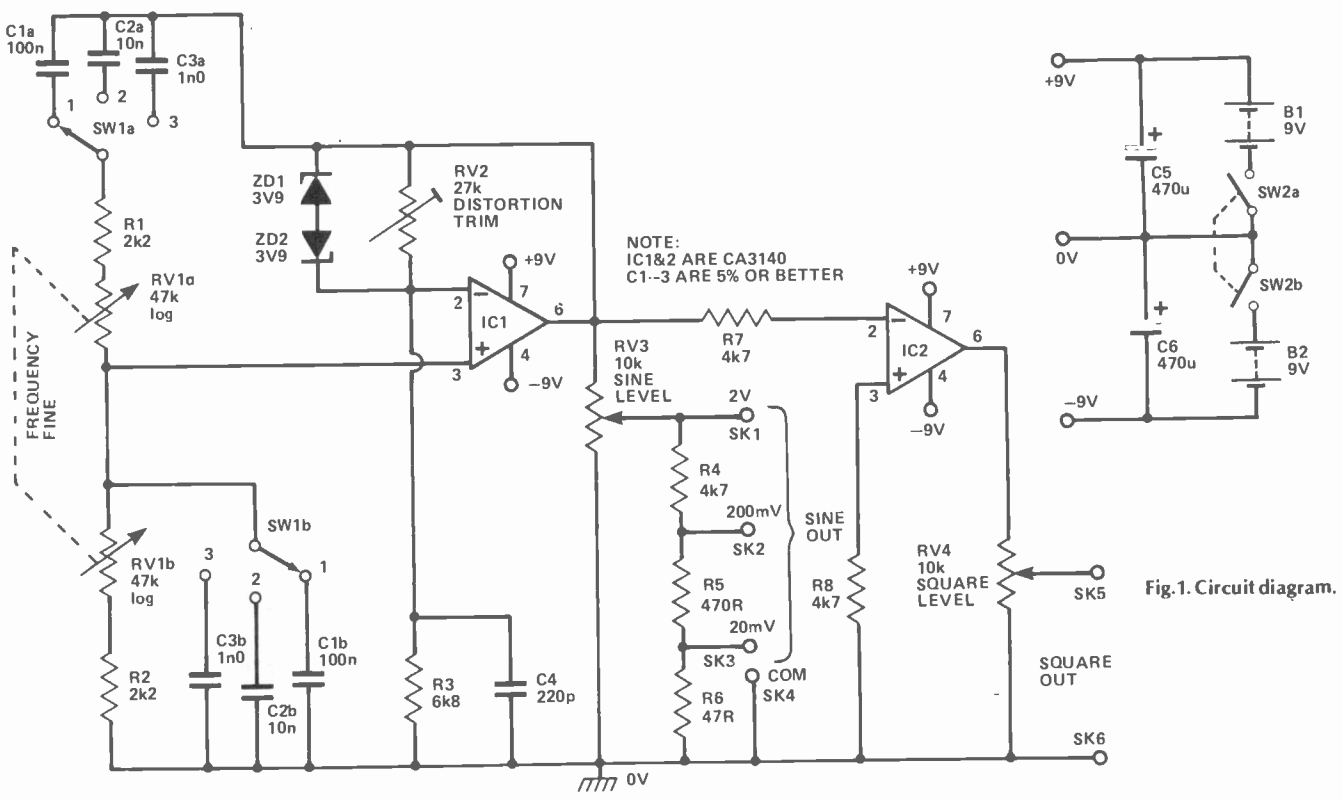
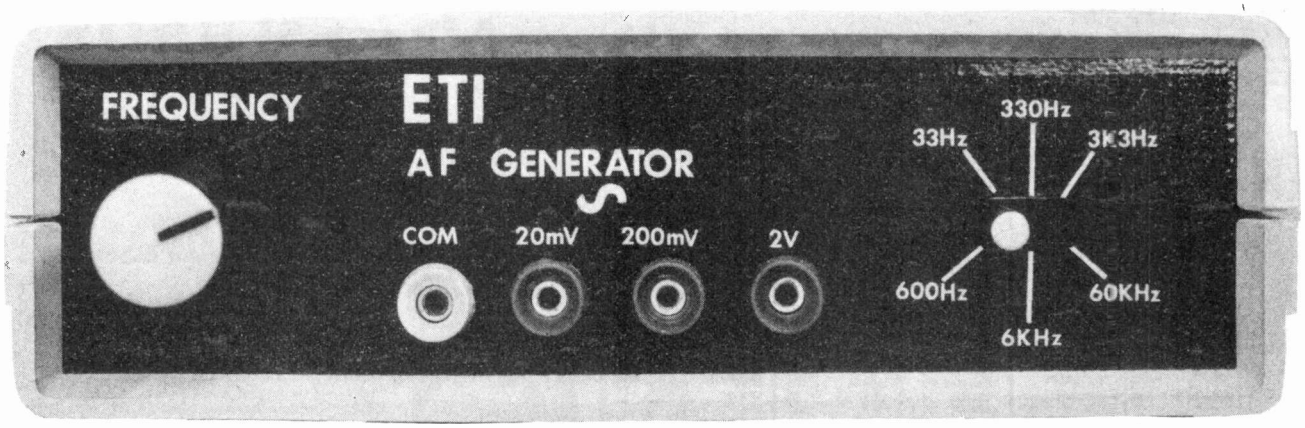


Fig.1. Circuit diagram.



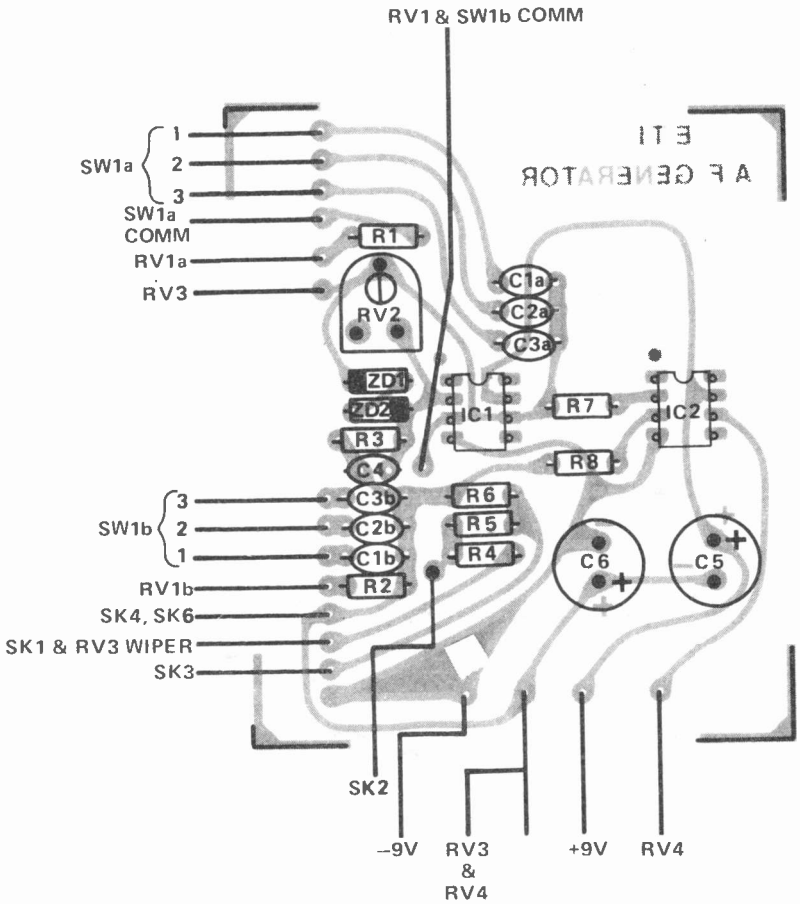
A simple front panel layout for ease of operation.

BUYLINES

There should be no problems in obtaining any of the components used in the AF generator as all are common types.

The case we used for the project is available from O.K. Machine & Tool Ltd. Order as CM5-125. Phone 0703-610944.

Fig.2. Component overlay.



PARTS LIST

AF Generator

Resistors all ¼W 5%

R1,2	2k2
R3	6k8
R4,7,8	4k7
R5	470R
R6	47R

Potentiometers

RV1	47k logarithmic dual gang
RV2	22k horizontal miniature
RV3,4	10k linear

Capacitors

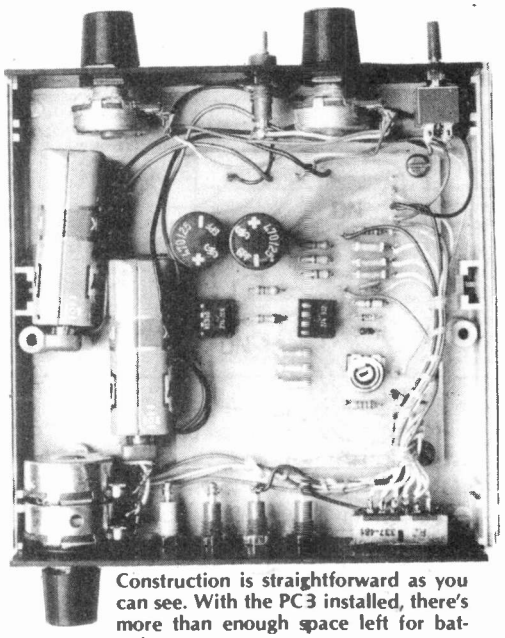
C1a,b	100u 5% polycarbonate
C2a,b	10u 5% polycarbonate
C3a,b	1u0 5% polycarbonate
C4	220p ceramic
C5,6	470u 25V electrolytic PCB type

Semiconductors

IC1,2	CA 3140

Miscellaneous

SW1 2 pole 3 position slide switch, SW2 DPDT miniature toggle, SK1-6 to suit, case (see Buylines), PCB.



Construction is straightforward as you can see. With the PC3 installed, there's more than enough space left for batteries.

ETI

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Address .....

Total Sum Enclosed £

ETI 11/80

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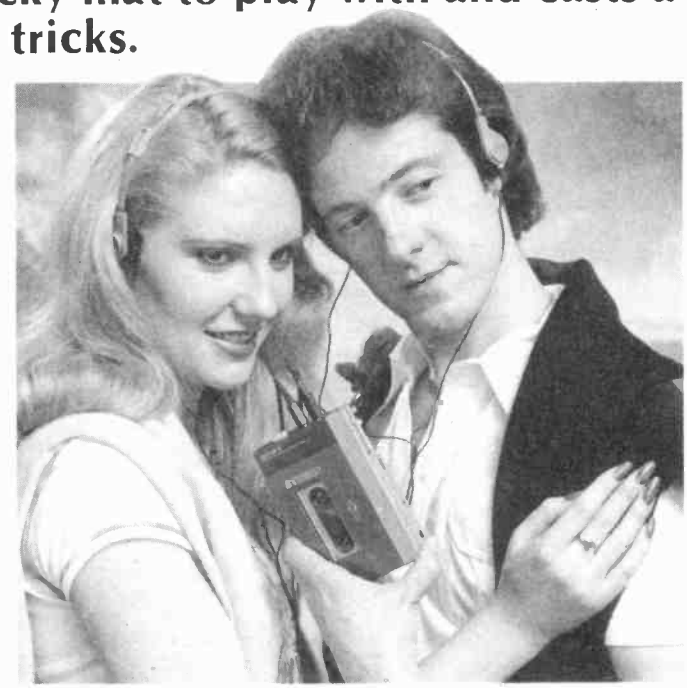
AUDIOPHILE

Disguised as Father Christmas, Ron Harris presides over our Sony competition Prize Day, finds a sticky mat to play with and casts a critical eye over a budget box of tricks.

Competition results time again. A few Audiophiles ago I ran that appalling, tasteless and thoroughly despicable Sony publicity photo for the 'Stowaway' portable tape player and asked for your captions . . . As usual you did not disappoint me. Six million pieces of paper later I think we have a winner. Well, almost. In fact, *two* winners, as I was unable to make up my mind between two very witty submissions.

Mr B. D. Barrett of Pickering, Yorkshire and C. R. Thorn of Gloucester (who did not bother to define gender more closely) are, therefore, declared joint 'Wit of the Month' and duly rewarded a year's subscription to ETI. Anyone who thinks second prize is two year's subscription to ETI had better leave now, lest he lose his vitals.

There were many more worthy attempts, but by far the most popular line was "O.K. Scotty, beam us up" which lost by sheer weight of numbers! I have given a few of the better efforts below, the winners first:-



Left: the great Sony picture show which started all this lunacy.

Joint Winners: "Are you *sure* this will stop me getting pregnant?" Mr R.D. Barrett, Pickering

"Darling — I know it's cheaper than a choir, but this *is* our wedding . . ." C. R. Thorn, Churchdown

Also worth an honourable mention or three:

"His equipment is so tiny . . . but I love the performance". Mr J Wakewell, Shirley, Surrey.

"Here — can *you* do this with your thumb?" Un-named of Maidstone. (Blew it, didn't you?)

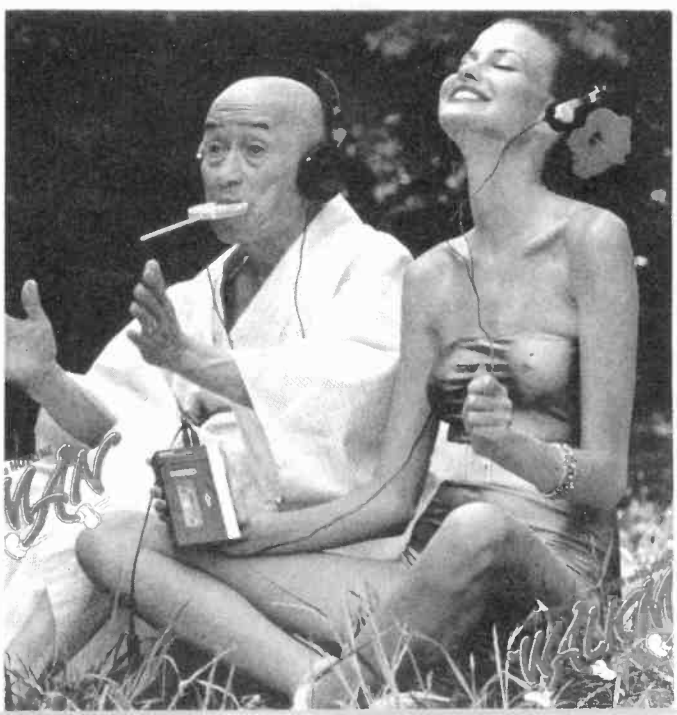
"So this is where you keep the spare batteries . . .". J. Clarke, Sutton Coldfield.

"Darling are you sure your pacemaker's working O.K.?" S. McKinty, Co. Down.

"Step two: place your right hand on your partner's left . . ." P. Skinner, Derby

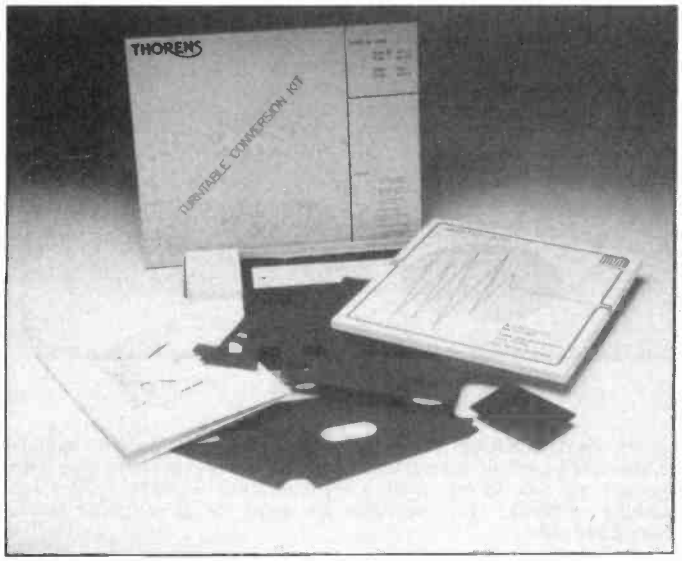
A final chord in this symphony of corn and photographic pap. Just to prove that PR agencies are capable of exhibiting bad taste on a worldwide scale, I reproduce below the hand-out photos for the Stowaway from Japan and the USA . . .

No words of mine could do them justice, therefore — no comment.



On The Mat

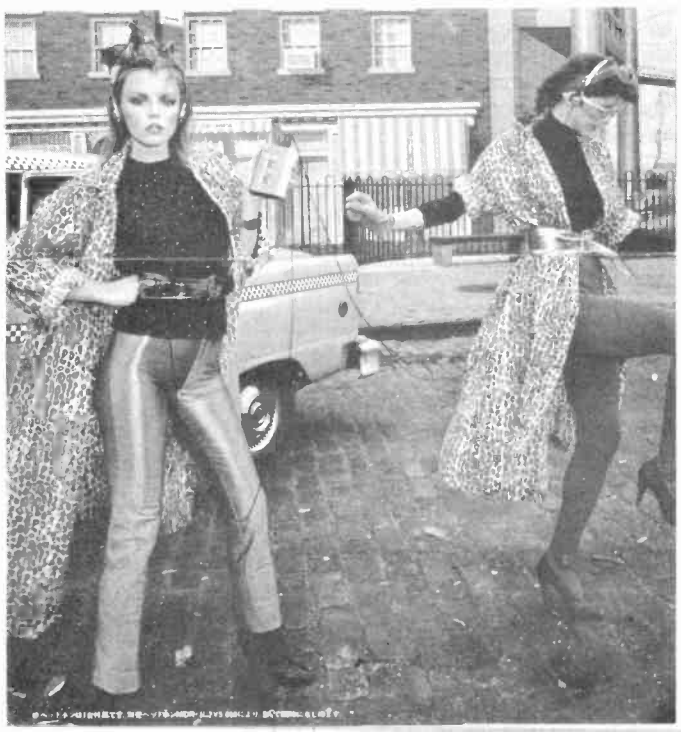
Following on from last month's review of the Thorens TD160S turntable, I have more news of the 'conversion' kit to upgrade other models to a similar performance. Similar, but not equal. It seems that most



Thorens conversion kit includes self-adhesive damping material to improve the sub-chassis behaviour under resonant conditions. A new arm-board and turntable mat is also included.

of the changes to the standard 160 which were made to create the 160S are the brainchild of Cambrasound (a merged version of Metrosound and Cambra International) Thorens UK importer.

One point of difference exists, however, over the turntable mat. Thorens went their own way and produced a very heavy and sensible specimen which resides in the 160S production model. Metrocare have their own mat — and it is this that is included in the conversion kit. As this item is marketed separately, as a general application turntable mat, I thought it worth a closer look.

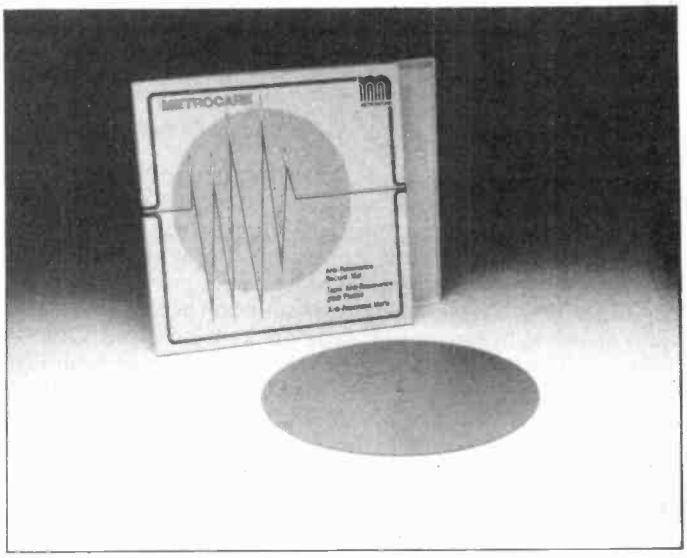


It is formed from a silicon elastomer, which is virtually 100% pure polymer. That description makes about as much sense to me as the Arabian Daily News. The material has a very high surface tension — higher on the face which will be in contact with the turntable.

Practically this means it is "sticky" to the touch and bonds very well to the metal surface. The record is effectively held across its entire surface, with no room for air gaps.

Resonant Peaks

Metrocare claim the biggest benefit lies in the reduction of those resonances which are inherent in all cast platters and cite an improved upper-bass and mid-range reproduction as the audible return for the £16.75 retail price.



Above: the very persistent Metrocare turntable mat, as fitted to the Thorens conversion kit, but not to the production 160S decks. A very high surface tension endows it with considerable LP holding qualities.

Because of the mat's amazing ability to hold dust, the Metrocare must be kept clean — and the deck covered at all times when not in use. Removing records from the mat has to be done carefully as the bonding is not just good, it is excellent. LPs are somewhat loathe to leave.

Having tried the Metrocare on a few decks, including the TD160S, I can confirm that is is indeed a worthy effort. Compared to Thorens' own creation it displays an improved mid-range and tighter control of the bass. Subtle changes, but clearly audible nonetheless. I cannot understand why Thorens would not accept the whole of the advice offered, and fit Metrocare to the TD160S production model. Swiss independence, I suppose. Ah well.

Trying the Metrocare on other decks, including some budget machines, suggested that it has much to offer most hi-fi users in that an audible improvement was obtained on all the decks we dropped it on. It is probably the only one of these "super-mats" that can claim such universal application. ➔

Above: the Trio KA300 budget amplifier. The appearance is certainly striking and bereft of superfluous controls. Loudness could have been disposed of, too, in my opinion without much weeping wailing and gnashing of teeth. Tape facilities are good for an amplifier in the under £300 class.

Budget Trio

In response to readers' calls for budget hi-fi reviews (and because someone told me Felicity Kendal had a Trio hi-fi) I have been taking a look at the new KA-300 from Trio, a 30 + 30 low price amplifier which will retail at somewhere in the region of £80-£90.

Facilities offered are not at all bad for this price area and dubbing between two tape decks is possible. One set of tape sockets (phono) is included in the front panel for ease of access. Not a bad idea if you can hide them somehow with one of those flaps the Japanese are so enamoured of, but a little ugly otherwise. In fact the KA-300 is anything but pretty all round! The controls are well sited and smooth to operate, but the appearance is downright ugly in my opinion. The black plastic ribbing which pops up all over the front panel gives a very strange look to the whole thing.

Individual is perhaps the kindest label to hang there!

On test the Trio acquitted itself well, exceeding the spec on every feature and giving a very competent electrical performance. Power available was somewhere around the 35 W a channel mark and this is well maintained across the audio spectrum. Noise ratios were commendably low for the price and distortion was at a level where it would not be a problem. The test results give you the details, if you're interested.

TABLE ONE

Output Power	; 40Hz - 20kHz	;	25W
Power Bandwidth	; at 0.01% THD	;	10Hz - 45kHz
S/N Ratio, unweighted	; phono	;	60dB
	aux, tuner, tape	;	65dB
Damping Factor	; 8R 40Hz - 20kHz	;	60
Input Sensitivity	; phono	;	2mV at 50K
	aux etc	;	130mV at 27K
Distortion	; THD 1kHz at 20W	;	0.1%
	intermodulation	;	0.05%

Test results for the Trio KA300 amplifier. Noise ratios are excellent. The impedance on the aux input is, however, somewhat less than excellent! A minimum of 50K is to be preferred.

Listen with Trio

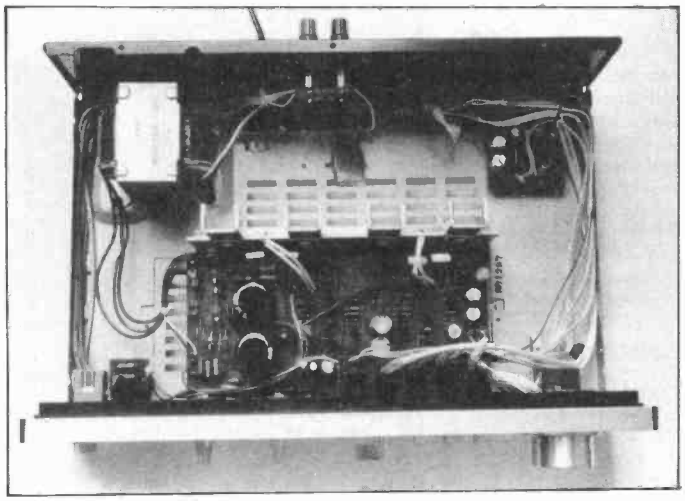
It is always difficult to decide exactly how to audition budget equipment. Do you hook it onto a top flight set-up, in order to exactly determine its strengths and weaknesses, or use the type of system it is designed to run with and accept that you are only able to judge it comparitively against a rival unit?

My own approach is simply to do it both ways! Never one to makes things less complex, if at all possible. Hence the Trio was substituted into my reference system (driving Kef 105 IIs at one point!), first of all to try to get an absolute idea of performance before moving on. I might add that the Seoum amplifier on offer elsewere in this issue was also put to the test and used throughout as a comparison to the Trio. Final listening was carried out with reference to a friend's system using the NAD 3020, which is perhaps the best sounding unit in this price bracket.

Having now heard the KA-300, I think that NAD have little to worry about. On an absolute basis the Trio has poor bass control and a tendency to "harden" on complex material. The Seoum sounded a good deal clearer and coped with most material well, although the noise was higher than with the Trio.

On the 'plus' side, the KA-300 is possessed of a good signal-to-noise ratio on both phono and tape and is well engineered. Against that, it has a good sound quality that is bettered by competitors, such as the NAD 3020 and the Seoum, and a highly individual appearance that you will either love or hate.

Sorry Trio, I can't recommend this one at all.



Above: an internal view of the Trio KA300. Lots of space is there not? Surely a smaller cage could have been found without jeopardising the signal to noise ratios too much?

Will readers using the Audiophile hi-fi enquiries service please remember to quote full details of the hi-fi system they are using. It is of great value to me in trying to sort out problems to know what it is I'm trying to sort out!

Letters Pray

Dear Sir,

I am upgrading my system and have been told that what I ought to change next is the turntable. This is a Thorens TD150 and an SME 3009 and a Shure M75ED cartridge. Amplifier: Armstrong 621. Speakers KEF Cadenzas.

My friend told me to buy a Linn as this will improve my system more than anything else. But this will cost me over £300 and this is more than I paid for the whole system, I wanted to be sure. What would you suggest I do?

Yours sincerely

F. Kendal

London

Hang on whilst I recover from the heart-attack that that name and address induced . . . People with *that* name should make it clear at the start who they are *not* — not who they *are*! . . . Come on heart, don't fail me now . . . you can make it . . .

Anyway, Mr Kendal, the first thing I would advise you to do is take your 'friend' on a one way trip to the docks in brand new cement shoes. It is about all he deserves. If your TD150 is in good condition, a Linn will make little, if any, difference to your system. A better immediate upgrade would be to change the cartridge. If you like the Shure sound then the V15 IV is an excellent buy. If you fancy a change then give the Goldring G900 IGC or Empire 600 LAC a try. After that both the amp and speakers could well be replaced — in fact, the deck is the last thing to change! **ETI**

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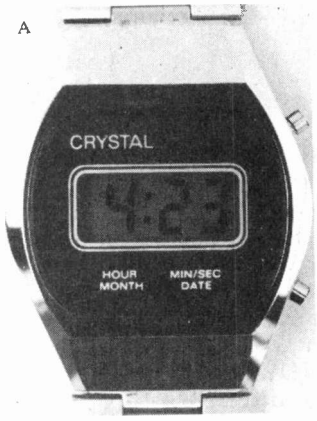
GENTS 5 FUNCTION LCD

A



This is the foundation of our range and is ideal for the man requiring the basic functions of hours, minutes and seconds, with month and date. A backlight is included and the stainless steel strap provided is fully adjusted to suit any size of wrist. Guaranteed for one year, this watch represents fantastic value at only

£4.95p

HERE IS THE AMAZING 12/24 HOUR ALARM/CHRONOGRAPH

D

Along with the usual time and date displays, this multi-functional timepiece has a 24 hour alarm and a 1/100 second stopwatch. The time may be set to operate in 12 or 24 hour mode and the date can be in English or American format. The day of the week is continuously indicated and the stopwatch display may, on command, be frozen to show split/laptime while the stopwatch continues to run. Stopwatch operation does not effect normal time keeping. £12.95 only for this model. Also available with solar energy panel to conserve energy during daylight hours for £14.95

FROM **£12.95p**

ILLUSTRATED BELOW IS THE LADIES 5 FUNCTION LCD.
This watch has the same time and auto calendar functions as the basic gents model described above, together with backlight and adjustable strap to suit the daintiest of wrists. It's compact, pleasing appearance makes it a very practical day watch and it is also often used for boys and girls. Available in black or white face.

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B

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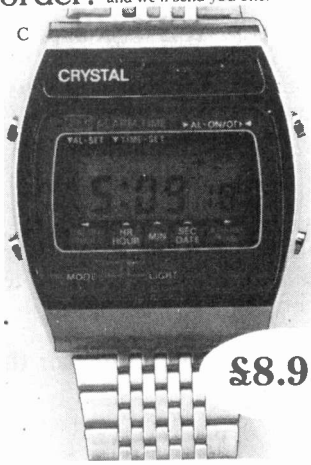
E

LADIES QUARTZ LCD DRESS WATCH

This attractive ladies model with the standard 5 functions of hours, minutes, seconds, month and date has literally sold in tens of thousands. Available in gold or silver colours with 'sugar coated' finish. Please state first and second choice of square, round or oval design.

£8.95p

C



GENTS LCD ALARM WATCH

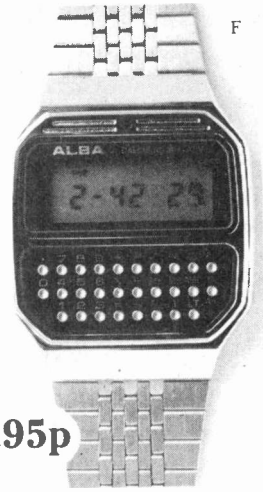
This model represents fantastic, incredible value for money. The 6 digit display continuously shows hours, minutes and seconds, or may be changed at will to hours, minutes and date. Its effective alarm is extremely useful and may be set to any time within a 24 hr. period. In addition, there is an alarm indicator, 4 year calendar and snooze repeater.

£8.95p

THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH

If you want a watch from the top end of the market this is the one for you. Full calculator functions plus memory and percentage are combined with time and alarm functions to make this item an outstanding buy. Manufactured in Japan at the same factory that produces models for probably the most famous name in the watch business, this device represents sheer quality at an unbelievable price. Comes complete with backlight and button operating tool carried in the strap clasp. We advise you to order quickly whilst stocks last.

F



£39.95p

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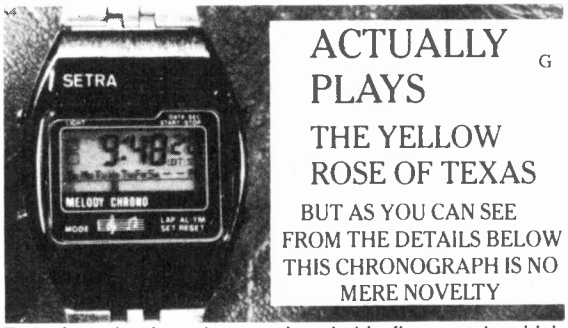


G

ACTUALLY PLAYS
THE YELLOW ROSE OF TEXAS

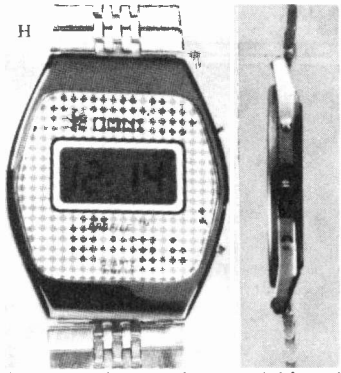
BUT AS YOU CAN SEE FROM THE DETAILS BELOW THIS CHRONOGRAPH IS NO MERE NOVELTY

Today's technology has produced this fine watch which incorporates a musical alarm which plays a complete verse of 'The Yellow Rose of Texas.' Other functions included are as for model number 1. With stop watch.

£14.95p

NEW TO OUR RANGE, WE COMBINE PRECISION AND STYLE IN THIS – THE SUPER SLIM GENTS 5 FUNCTION CHRONOGRAPH

H



JUST TO GIVE YOU AN IDEA OF THE ULTRA SLIMNESS OF THESE WATCHES WE HAVE ILLUSTRATED A SIDE VIEW OF THE SUPERSLIM DIGITAL. BELOW, WE HAVE ELABORATED ON SOME OF THE TECHNICALITIES:–

These watches need no special functions to make them stand out in a crowd – their slimness serves that purpose. If you've been put off digital quartz watches in the past because you require an ultra-slim design, now is the time to change. Is equipped with standard 5 functions and backlight.

£9.95p

MAINS DIGITAL ALARM CLOCK

I

A very practically sized mains operated digital alarm clock – this item is extremely well finished and looks equally at home by the bedside or in the living room. With snooze/repeater alarm you could not even buy the components to build your own for this price. Available at the amazingly low price of only

£8.95p

AND FINALLY, WHAT MUST BE THE ULTIMATE IN SQUEEZING A QUART INTO A HALF PINT POT! THE INCREDIBLE MINIATURE LCD TRAVEL/ALARM CLOCK

J

As you can see from the photograph above this device is tiny and yet it continuously displays hours and minutes with auto calendar and night light. Invaluable for the busy traveller or simply for use in the modern home, it comes complete with its own travelling case and can easily be carried in top pocket or the smallest of handbags. It has even got a stand for upright position on table, shelf or sleeping compartment. An unusual gift to yourself or others at only £10.95.

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		.								TOTAL AMOUNT = £

NAME Mrs Miss Ms Mr
ADDRESS

POSTCODE
I enclose a cheque/PO to KEELMOOR LTD
Or charge my Access or BARCLAYCARD (tick as applicable)
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TOTAL – £ + 50 per item P&P
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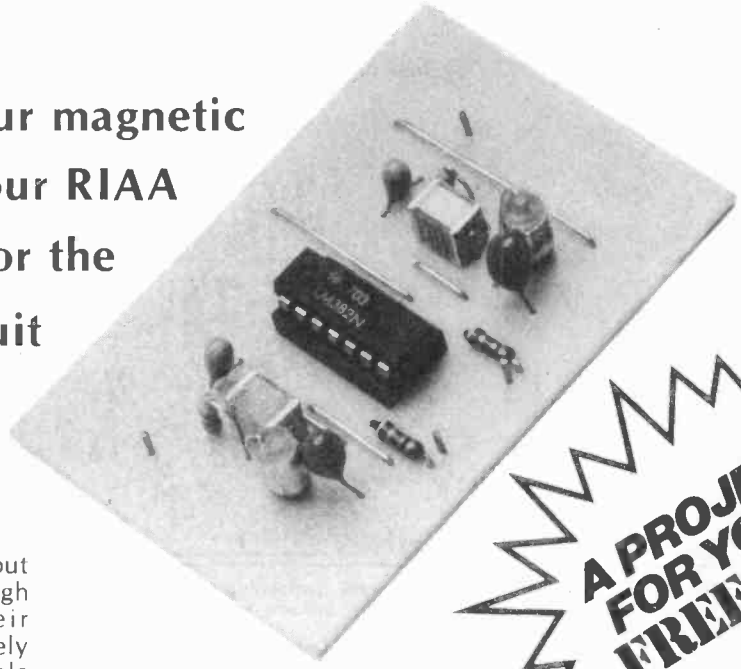
ETI

RIAA PREAMP

Sounds amazing. Listen to your magnetic cartridge burst into life with our RIAA equalised preamp, designed for the ETI Multi-Option Board. Circuit design by Keith Brindley.



Magnetic cartridge pick-ups have very low output levels and consequently require low noise, high gain preamplifiers to boost their signals. Op amps for this application are relatively abundant nowadays. But, things aren't quite that simple — not only is the output level of a magnetic pick-up low, but it varies with frequency. At the top end of the audio spectrum (ie 15-20 kHz) the signal is about 40 dB up, (ie 100 times) that of the lowest end of the range.

The Record Industry Association of America (RIAA) laid down the rules for the frequency response curve, so that when designing such a preamp stage the engineer has only to calculate suitable values for the components in an op amp feedback loop. What is needed is an amplifier response which *diminishes* with increasing frequency over a range of 40 dB, to compensate for the response of the cartridge and give an overall flat output. Given a microcomputer, a sharp pencil and a bottle of vodka it should take him — ages. But why bother, it's all done nowadays (as it often is!) on one chip — the LM382.

Cue Cavalry

National Semiconductor came to the rescue with the introduction of this device, a wide-range supply voltage (9-40 V) preamp which, with only a handful of other components, gives an RIAA preamp featuring low noise, high gain and the required frequency response.

Construction

The only components which need correct polarisation are the four tantalum capacitors and the IC, so check the overlay carefully before soldering them into position on the ETI Multi-Option Board.

The input and output connections should be made with screened lead, the screen being taken to 0 V. The only thing to note here is that the input leads must be as short as possible, because the high gain involved in any preamp circuitry makes them very susceptible to hum and noise pickup. Short screened leads help to minimise this problem.

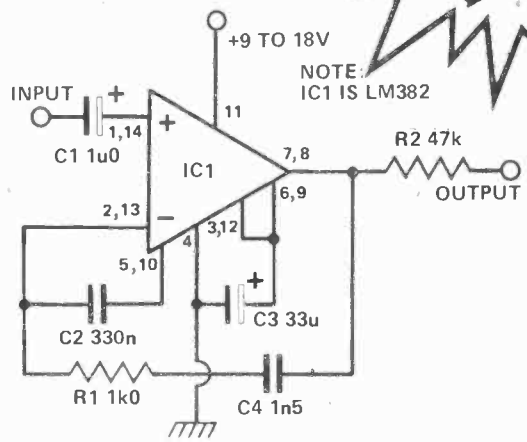


Fig. 1. Circuit diagram of one channel of the preamp.

HOW IT WORKS

The feedback loops in any RIAA amplifier are fairly conventional and apart from different component values, any one circuit is similar to another. What makes the LM382 novel is the internal resistor matrix available on the chip. This enables an exceptionally low number of external components.

For the technically minded the RIAA transfer function of such an amplifier can be stated as:

$$G = \frac{(1 - jf_2/f)}{(1 - jf_1/f)(1 + jf/f_3)}$$

where $f_1 = 50$ Hz, $f_2 = 500$ Hz and $f_3 = 2.12$ kHz.

This defines the corner frequency exactly and also the various slopes of the frequency response. It just so happens that capacitor/resistor feedback combinations can be used to achieve the required amounts of gain, corner frequencies and roll-offs. The internal resistor matrix of the LM382 simply allows us to use fewer external components in the circuit.

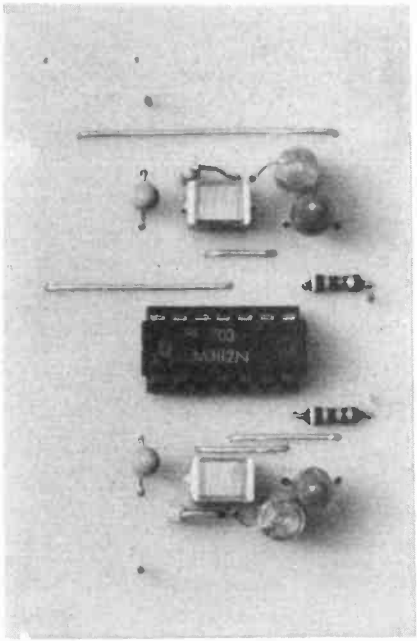
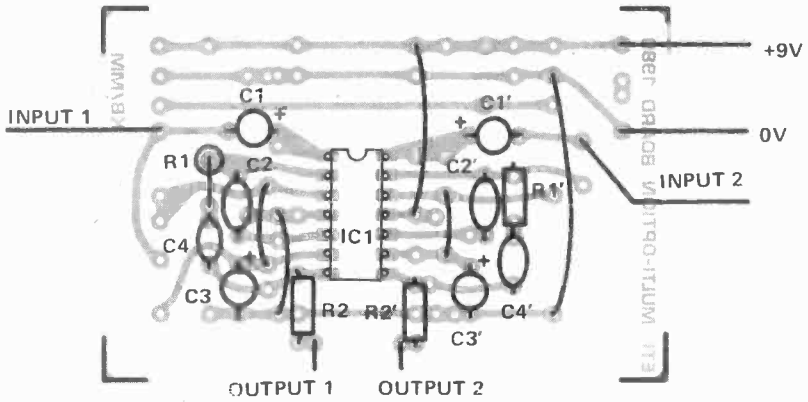


Fig. 2. (below) Component overlay of the stereo preamp fitted onto the Multi-Option PCB.



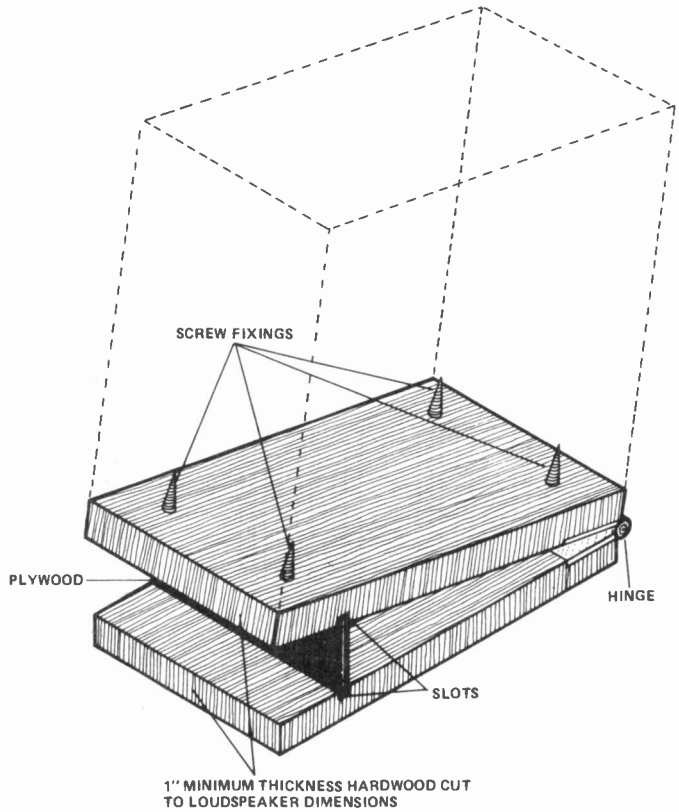
BUYLINES

The one chip and handful of components used should not present any problems. They should be readily available from suppliers advertising in this issue.

PARTS LIST

Resistors all ¼ W 5%	
R1	1k0
R2	47k
Capacitors	
C1	1u0 35 V electrolytic
C2	330n polycarbonate
C3	33u 10 V electrolytic
C4	1n5 polystyrene
Semiconductors	
IC1	LM382
Miscellaneous	
ETI Multi-Option PCB	

TECH TIPS



Getting off the ground — cheaply

G. Adams, Poole.

The cost of loudspeaker stands prohibit many from buying them, although they are important to floor-standing arrangements for two reasons. They reduce possible colouration via floorboards etc. and, more importantly, they effectively heighten floor-standing loudspeakers so that the sound from each is directed where it should be, to one's ears, *not* to the upholstery and one's ankles!

With the latter problem particularly in mind, this design was finally decided upon. It is rather uniquely versatile, in that by using different sizes of plywood any degree of lift may be obtained. However, a lift of around 10° is considered a useful stone upon which to build.

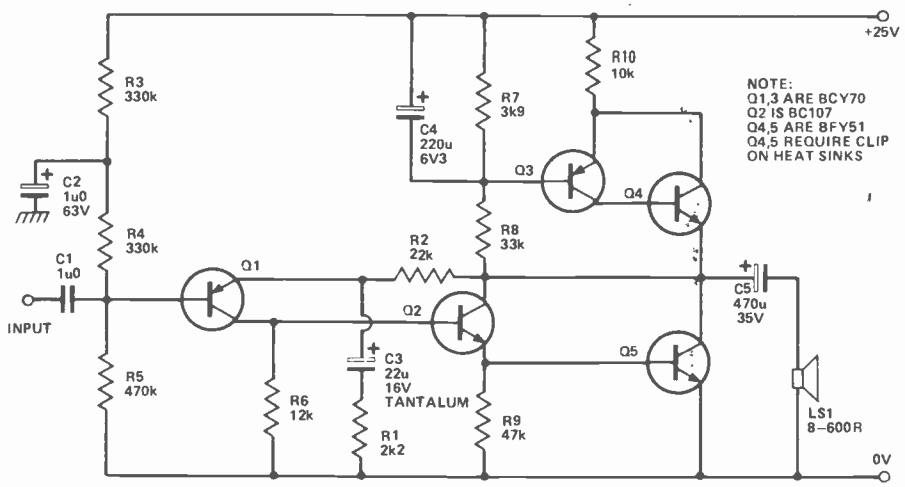
High Quality Headphone Amplifier

A. J. Jones, Cobridge

This circuit is capable of high performance using low cost, readily available components. The class A amplifier is designed to drive efficient, high impedance headphones of 150R and above, although it will drive 8R headphones with reduced performance.

Feedback is applied by R1,2 and gain with the specified components is 11. For maximum output the input sensitivity is 0 dB. Q3,4 and C4 form a gyrator circuit and present a high impedence to AC signals. This gives the circuit a high open-loop gain. Quiescent current is set by R9 (approximately 60 mA).

Performance is good with distortion and noise measured on Radford test kit at less than 0.01% for maximum output. Noise is less than −80 dB unweighted. Power bandwidth is less than 10 Hz to over 50 kHz. Slew rate is greater than 5 V/uS.



Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH–TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

Efficient P.A. Amplifier

N. D. Sheldon, High Wycombe

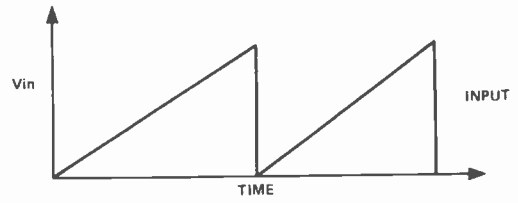
The efficiency of this amplifier is so high that an output of 3 W can be obtained with a BC107 used as the output transistor, even without a heatsink.

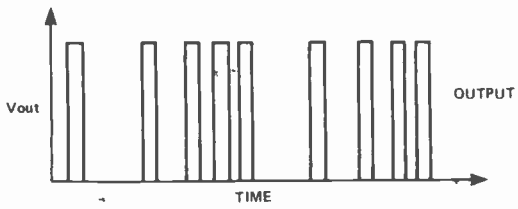
The amplifier consists of a voltage controlled pulse width oscillator working at about 6 kHz, driving a class D output stage. Since the output transistor is either hard on or completely off, the dissipation is minute — hence the high efficiency. The output waveform bears no resemblence to the input, but the integral of the output waveform is proportional to the integral of the input waveform, both with respect to time.

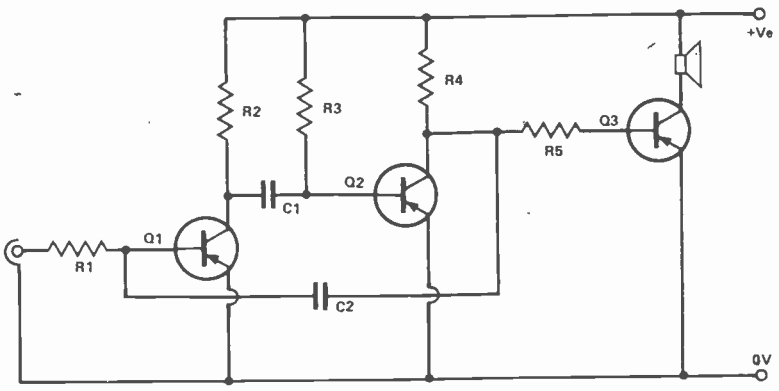
A table of component values has been given in order that any amplifier with an output of between 3 W and 100 W can be constructed. Still higher powers up to 1 kW can be obtained.

The drawback is that it produces about 30% distortion and can, therefore, be used for sound reinforcement only. It is especially suitable for public address systems, as speech is completely intelligible.

POWER (W)	R4	R5	Q3	HEATSINK	SUPPLY/V	O/P TRANSFORMER
3	1k5	390R	BC107	50 C/W	15	–
10	1k5	390R	BFY51	22 C/W	24	15R:8R0
30	1k0	270R	BD139	10 C/W	40	22R:8R0
100	820R	180R	BD139	5 C/W	60	35R:8R0







R1 27k	C1	1n8	Q1	BC107
R2 1k5	C2	1n8	Q2	BC107
R3 180k				

Digital Op-Amp

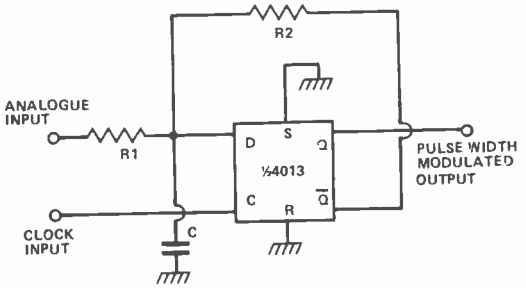
K. Wood, Leicester

One half of a 4013 package may be used as an amplifier, if one doesn't mind a digital output whose duty cycle is proportional to the expected output voltage. This could always be filtered to recover an analogue output.

Clock pulses have to be applied as indicated and these should be considerably higher in frequency than the required bandwidth. Gain is R2/R1 and the time constant R1R2C/(R1 + R2) should be longer than the period of the clock pulses.

Uses of the circuit include the following:

1. Take pulses from the zero crossing point of the mains, drive a triac with the output and you have proportional power control without RFI.
2. Switch driver transistors with the output using a fast clock and you have a high efficiency PWM audio amplifier.



Interior Light Delay

S.A. Johnson, Newcastle

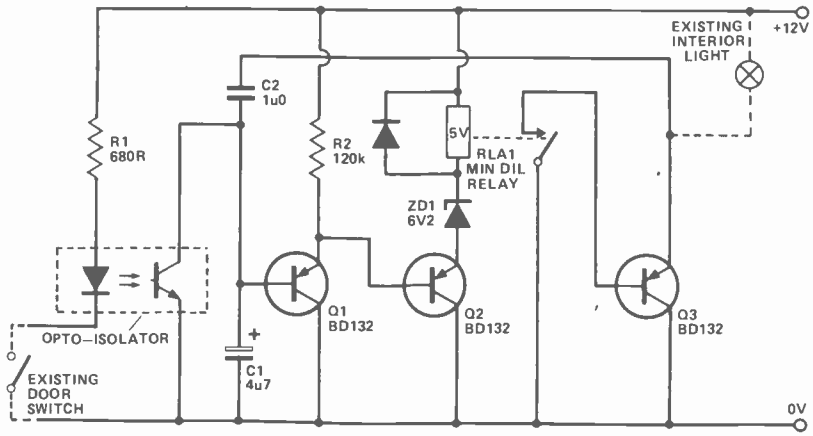
The circuit shown will delay the car interior light by about 10-15 S, depending upon the time constant of R2-C1.

One big fault with most delay units is that the delay is so long that the light is still on when you drive away, which can be very annoying at night. This unit, however, will extinguish the light either 10-15 S after the door is closed, or when the engine is started, whichever occurs first. The unit may be fitted without running any extra wires to it and may be fixed behind the interior light.

Capacitor C1 charges up through R2; thus turning Q1, Q2, RL1 and Q3 off after 10-15 S. When the door is opened C1 is discharged by the opto-isolator and begins to charge up after the door is closed.

If, however, the engine is started before 10-15 S the supply voltage will drop sufficiently to de-energise RL1, (approx 3V) and give C2 a positive pulse via Q3 which will charge C1 up sufficiently to switch Q1 off. **NOTE:** The value of C2 and ZD1 may need to be altered to get this effect.

The unit draws very little current when not in use and has only ten components.



Multivibrator

E. Vaughan, High Wycombe

The frequency of a conventional multivibrator is controlled by the R-C times constant of its feedback loops. This circuit has fairly good rise and fall time and will operate at repetition rates as high as 10-15 MHz. The disadvantage of this kind of circuit is poor frequency stability. Also, the frequency can by affected by temperature, voltage variations, and variation (within tolerance ranges) between capacitors and resistors in the feedback loops, the latter affecting not only frequencies, but waveform symmetry.

With the circuits shown, all these disadvantages can be eliminated and the advantages of a conventional multivibrator will not be lost. The same number of components are required as the crystal or crystals replace the capacitor in one or both feedback loops. The resistor value in the feedback is not critical. As it is used with a crystal it no longer controls the time constant.

Both CT cut or AT cut crystals are suitable. The circuit in Fig. 1 uses a crystal of 7 MHz with a low activity. Crystal activity was down to about one tenth of its 7MHz value when in the circuit, so it was not possible for it to operate below 750 kHz. To get below this a higher activity crystal would have to be used. Varying the feedback resistor in a conventional multivibrator changes the frequency. This had no effect on the frequency the crystal controlled circuit. Then the capacitance of the 7MHzand3.5MHz crystals in Fig. 2 were measured and came out as 13pF and 12pF respectively.

These capacitors are not in the range that create an R-C time constant that permits the circuit to work at the above frequency, so there is no doubt the crystal was controlling the frequency. With a crystal the circuit operates only at its rated frequency. Frequency tolerances in the order of 0.001 to 0.0001 percent can be obtained with this circuit. The 2N2475 used is a very fast switch. If another transistor is used it need not be as fast, but should have a switching time that will permit operation at the desired frequency.

The circuit (Fig.1 modified) controls symmetry by employing different frequency crystals in the two feedback loops. R3 and R4 were changed to 10k and X2 to 3.5 MHz. The 7 MHz crystal remained in the second feedback loop. All other values are the same as shown in Fig. 1. This produces a symmetry of 2:1, but maintained a frequency stability of 0.007 percent with a 20 percent supply voltage variation. This modification has other advantages. It can be used to produce an extremely stable asymmetrical square wave. Crystals for this type of operation must have a harmonic relationship.

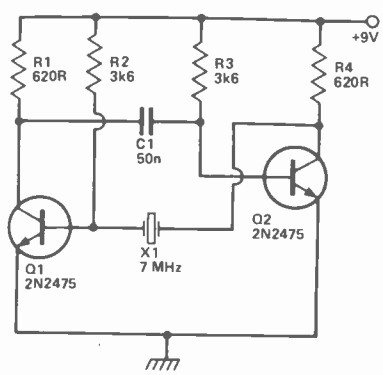


Fig. 1.

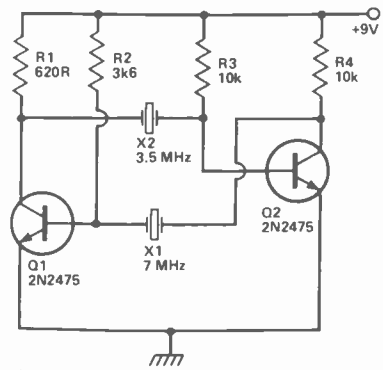


Fig. 2.

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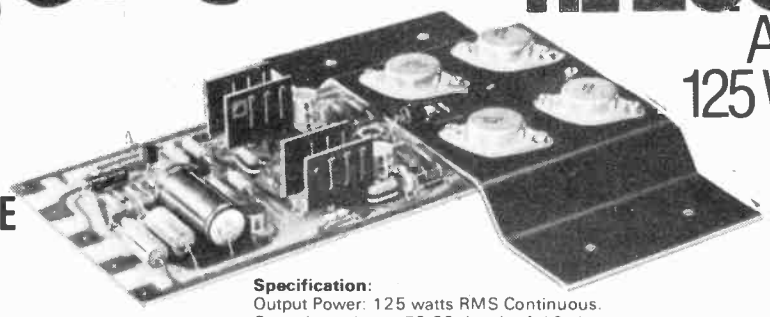

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STA5. 5 watts per channel Stereo Amplifier Kit consisting of: 2 x AL20 amplifiers, 1 x PA12 pre-amplifier, 1 x PS12 power supply, 1 x 2036 transformer and necessary wiring diagram **£22.14**

STA10. 10 watts per channel Stereo Amplifier Kit consisting of 2 x AL30 amplifiers, 1 x PA12 pre-amplifier, 1 x PS12 power supply, 1 x 2036 transformer and necessary wiring diagrams **£23.72**

STA15. 15 watts per channel Stereo Amplfier Kit consisting of: 2 x AL60 amplifiers, 1 x PA100 pre-amplifier, 1 x SPM80 power supply, 1 x 2034 transformer, 2 x coupling capacitors for 8 ohms 470mfd 30v and necessary wiring diagram **£42.27**

BI-KITS

STA25. 25 watts per channel Stereo Amplfier Kit consisting of: 2 x AL60 amplifiers, 1 x PA100 pre-amplifier, 1 x SPM120/45 power supply, 1 x 2040 transformer, coupling capacitors for 8ohms, 470 mfd. 45v, 1 x reservoir capacitor, 2200mfd 100v and necessary wiring diagram **£46.58**

STA35. 35 watts per channel Stereo Amplifier Kit consisting of: 2 x AL80 amplifiers, 1 x PA100 pre-amplifier, 1 x 2035 transformer, 2 x coupling capacitors 470mfd at 50v for 8ohms, 1 x reservoir capacitor 2200mfd 100v and necessary wiring diagram **£52.62**

BI-KITS

STA50. 50 watts per channel Stereo Amplifier Kit consisting of: 2 x AL120 amplifiers, 1 x PA200 pre-amplifier, 1 x 2041 transformer, 2 x coupling capacitors 1000mfd 63v, 1 x reservoir capacitor 3300mfd 100v and necessary wiring diagram **£68.87**

STA100. 100 watts per channel Stereo Amplifier Kit consisting of: 2 x AL250 amplifiers, 1 x PA200 pre-amplifier, 2 x SPM120/65 power supplies, 2 x 2041 transformers, 2 x coupling capacitors 1000mfd 100v and necessary wiring diagram **£97.38**

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SPM120/45. 45v Stabilised supply. Suit: 2 x AL60, PA100 to 25 watts **£7.34**

SPM120/55. 55v Stabilised supply. Suit: 2 x AL80, PA200 **£7.34**

SPM120/65. 65v Stabilised supply. Suit: 2 x AL120, PA200, 1 x AL250 **£7.34**

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2041. 2 amp 0-55v-65v. Suit: SPM120/55, SPM120/65v **£6.80**

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139. Teak Cabinet. Suit: Stereo 30, 320x235x81mm **£6.45**

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What About The Workers?

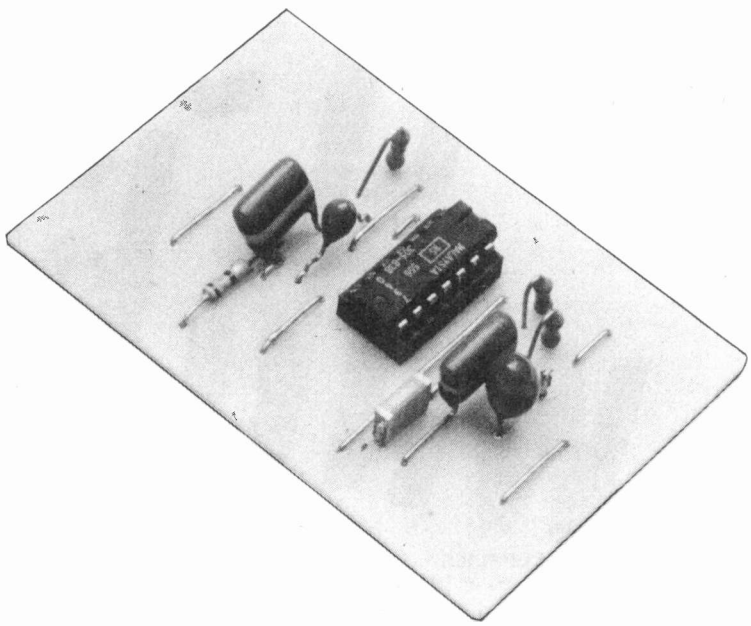
The 555 is a worker! It is adaptable to a wide variety of ideas and designs. It can operate on a power supply of 5 to 18 V. It can sink or source currents up to 200 mA.

The 555 has, therefore, been with us as a field leader for the ten years since Signetics first introduced it and you would be correct in assuming that it will be around for a while longer yet.

The ETI Touch Buzzer uses the dual version of the 555, which is designated the number 556. It is, of course, constructed on the ETI Multi-Option Board given away free with this issue and is extremely simple to build. You can utilise it as a rather clever VAS (Visitor Announcement System — otherwise known as a doorbell) or you can dream up your own uses for a very adaptable project. For instance, the output of the first half of the circuit from pin 5 of the 556 (see How It Works for circuit explanation), can be used to operate a low voltage relay to turn on and off other items of equipment and the circuit now operates as a touch switch.

Construction

No problems with this project — just be careful to get the two tantalum capacitors and the IC in the right way round and you can't go wrong. The overlay shows the position of all components and interconnections so study it carefully. The touch controls can be any suitable pieces of conductive plate which may be at hand.



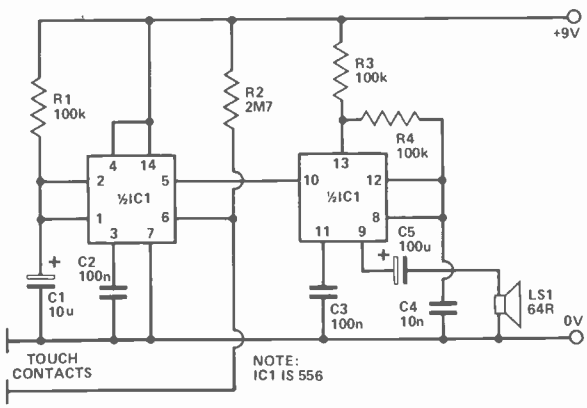


Fig 1. Circuit diagram.

HOW IT WORKS

The 556 is divided internally into two separate multivibrator circuits — a monostable followed by an astable. The monostable is triggered when the voltage at pin 6 of the IC is taken below one-third supply voltage. Normally pin 6 is held high by R2, a 2M7 resistor. However, when a finger is placed over the touch plates the skin resistance takes the voltage low.

The timing period of the monostable is given by the formula T = 1.1 x R1 x C1, which as all you budding mathematicians know (using the values of 100k and 10uF for R1 and C1 respectively) works out to be approximately 1 S. So every time the touch contacts are bridged the output (pin 5) of the monostable stays on (high) for about 1 S afterwards. The output is connected to the reset input (pin 10) of the second half of the chip, wired as an astable. The astable is prevented from oscillating when pin 10 is low and is allowed to oscillate when pin 10 is high. Thus, touching the contacts enables the astable to oscillate for about a second.

The timing components in the astable are set for a frequency of about 500 Hz.

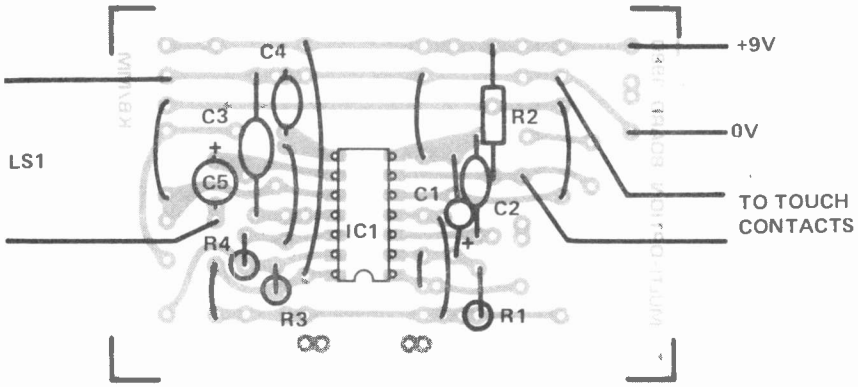


Fig 2. Component overlay. The touch contacts can be any available piece of conductor.

BUYLINES

All of the components used in this project should be available from the usual mail order companies who advertise in the magazine.

PARTS LIST

Resistors All ¼ W 5%

R1, 3, 4,	100k
R2	2M7
Capacitors	
C1	10u 10 V tantalum
C2, 3	100n polyester
C4	10n polycarbonate
C5	100u 10 V tantalum
Semiconductors	
IC1	556
Miscellaneous	
LS1	64R miniature speaker
ETI	multi option board
9 V battery and connector	
Touch contacts	

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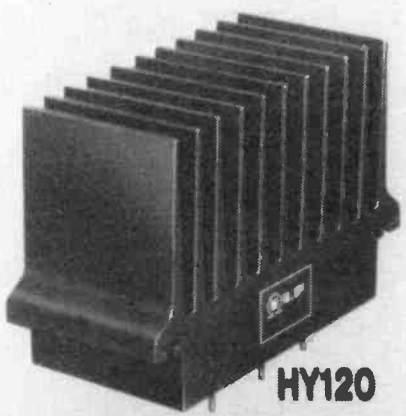

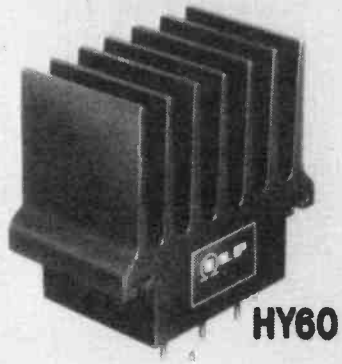

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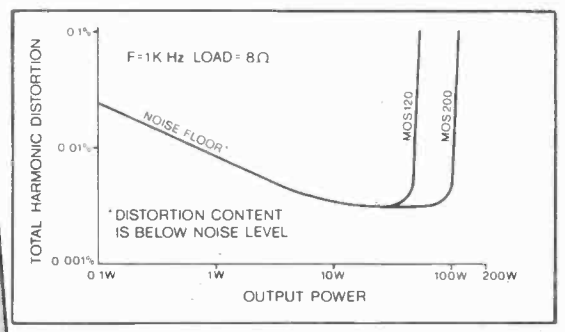

Load impedance both models 4Ω-∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz - 3dB

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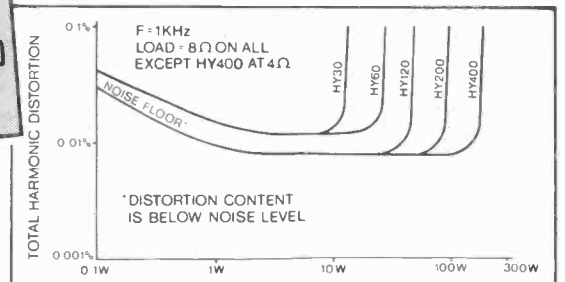
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15



Load impedance all models 4Ω-∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz - 3dB

THE NEW PROFILE EXTRUSIONS

The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.

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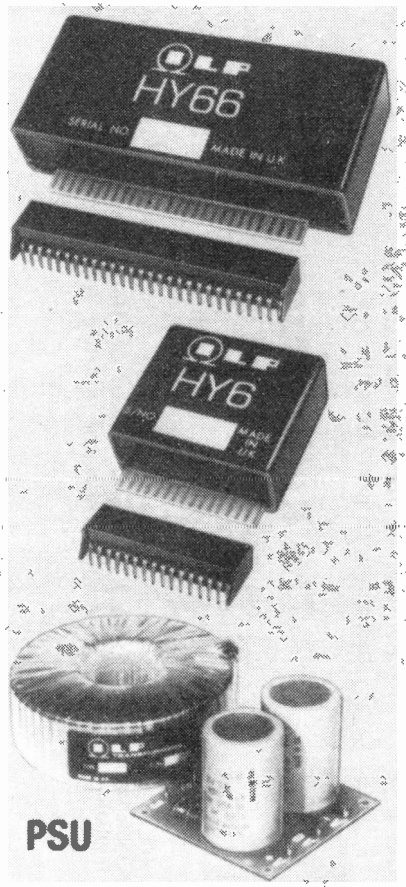
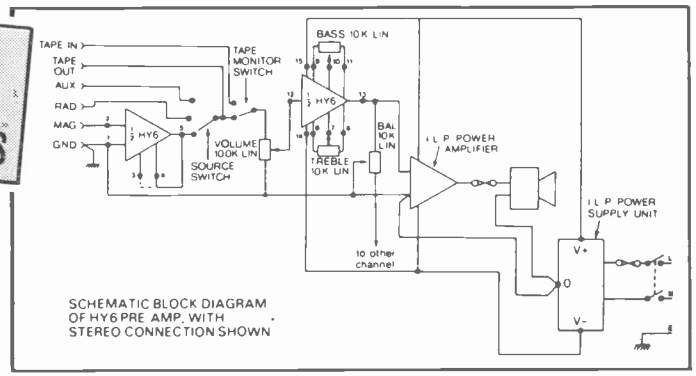
COMPATIBLE WITH ALL ILP MODULES



HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost. **Inputs Sensitivity** – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE AMP. WITH STEREO CONNECTION SHOWN

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PSU60 with toroidal transformer for 1 HY120	**£9.75** + £1.46 VAT
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PSU90 with toroidal transformer for 1 HY200	**£13.61** + £2.04 VAT
PSU95 with toroidal transformer for 1 **MOS200**	**£14.75** + £2.21 VAT
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ASTROLOGUE

The Farnborough Air Show opened its doors to the public again this year. Ian Graham reports on the Show with the latest news on the Space Shuttle.

The Space Shuttle was born in the heady days of the Apollo moon-landings, when America was the undisputed leader in the high-technology stakes. However, spaceflight gradually became 'ordinary', Press coverage waned, America's national pride took a couple of severe knocks and the world started downhill towards its worst post-war recession. These factors conspired to influence the Office of Management and Budget to cut the NASA Shuttle budget by thousands of dollars a year.

Going, Going, Wrong . . .

The earliest failures were in the main engine. Because of underfunding, NASA departed from its usual practice of proving each component separately before it was integrated into the complete system. The Shuttle main engine was tested as a whole. Consequently, some minor failures were accompanied by major engine damage. The first flight back-up engine was recently shut down automatically ten seconds into a 100 S burn. A defect in the operation of the high pressure liquid oxygen turbopump started a fire, damaging the turbopump, the main engine controller and some oxygen piping.

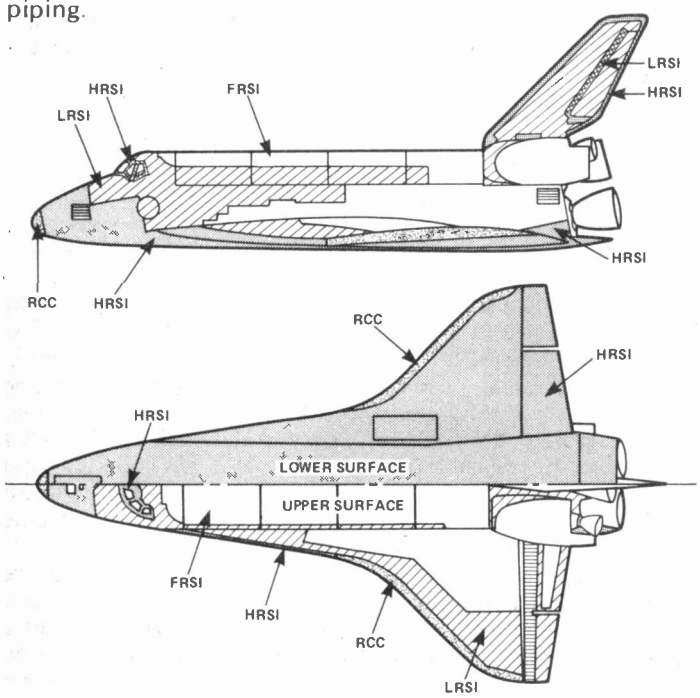
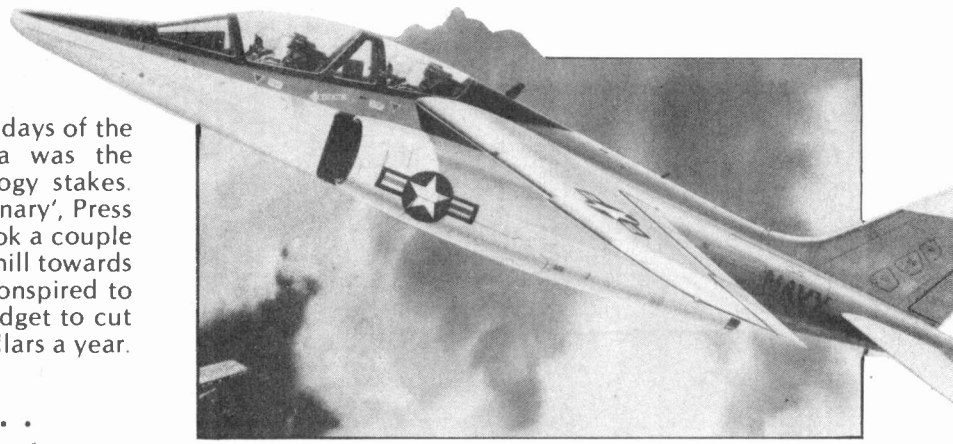


Fig. 1 The Space Shuttle's Thermal Protection System. RCC — reinforced carbon-carbon; HRSI — high temperature, reusable surface insulation; LRSI — low temperature, reusable surface insulation; FRSI coated Nomex felt, reusable surface insulation.



An artist's impression of Lockheed's new Alpha Jet during its three week tour of American military bases. The aircraft is competing for selection as a new advanced training aircraft for the US Navy.

Fact Or Fiction

The heat shield material used on Mercury, Gemini and Apollo was unsuitable for the Space Shuttle, because it could only be used once. On re-entry it slowly boiled off, dissipating the air friction heat. Heat conduction in the silicate developed for the Shuttle was almost zero. (You may remember the alarming photograph published at the time of a technician holding a tile at one corner while the centre glowed red hot).

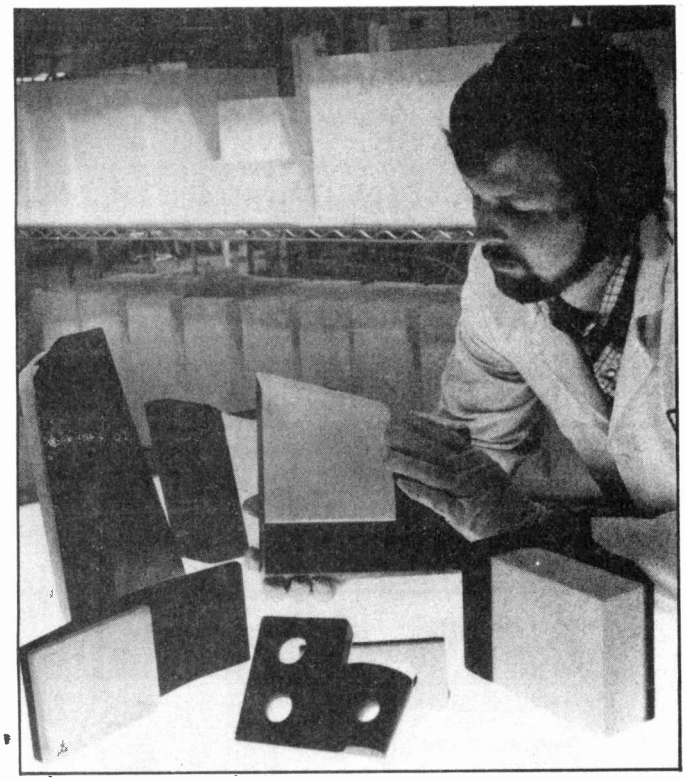
The process of bonding the tiles to the Shuttle's aluminium skin was not researched as extensively as the tile thermal behaviour. Indeed, air friction alone was sufficient to strip some of the tiles off during a short flight on the back of its 747 carrier aircraft. Several thousand more may have to be removed, strengthened and replaced.

Unfortunately there wasn't a Space Shuttle at the Air Show, but there was a Press conference dealing with NASA's plans for the 1980s. Naturally, though, most interest was focused on the Space Shuttle.

The first launch is still expected by next March. Although we have become accustomed to taking revised launch dates with a pinch of salt, March 1981 *does* seem to be more definite than the others. Some of those involved in making preparation at the Cape are beginning to get 'launch fever'.

The Retile Trade

November 23rd should see the completion of tile replacement work. I was given a rather distressing demonstration of the mechanical properties of the thermal tiles. A piece of tile material was held up and snapped between two fingers like a piece of polystyrene foam. The endurance of the tiles in service will determine when the Shuttle finally goes operational.



At the Lockheed plant in Sunnyvale, California, a technician examines some of the silica tiles manufactured for the Space Shuttle. As each tile is shaped to fit only one spot on the spacecraft, no two tiles are the same.

That is planned for the fifth flight in September 1982. However, if large numbers of the tiles have to be removed and replaced between flights, the operational date will have to be put back.

Shuttle flights are all booked up until 1986. Therefore, conventional Delta and Atlas-Centaur launchers will continue to fly until at least 1985.

The Shuttle's thermal protection is far from satisfactory. However, the production of the current series of Orbiters is so far advanced that no major hardware changes can now be implemented.

For equatorial flights, the Shuttle will be launched from Cape Canaveral. For polar flights, it will be launched from Vandenberg Air Base. The work necessary to prepare Vandenberg for the Shuttle should be finished in 1984.

Outdoors

The highlight of the Show was the flying display. I was deafened and delighted by a cross-section of the world's civil and military aircraft. The Shorts Skyvan demonstrated its short (and I mean *short*) take-off and landing capability. Lulled into a false sense of security by the Canadair Challenger and Shorts displays, I was deafened by the Dassault military aircraft. An Alphajet, Mirages and a Falcon screamed around the airfield.

Five Westland helicopters approached the airfield from all angles. Each entertained the land-bound throng and 'parked' in the air in line with its predecessor. The line of aircraft hung in the air for a moment in silent salute and then made off. The British Army have ordered 100 Lynx helicopters. The Royal Navy have ordered 70 to replace Westland Wasps. Total Lynx orders are currently approaching 300.

Stars of the display were the American fighters — General Dynamics' F-16 and McDonnell Douglas' F-15A and F-18. The US Air Force plans to buy no less than 1400 F-16s. The 200th was delivered recently. More than 500 F-15A Eagles have also been delivered. Each has a maximum speed of more than Mach 2.5.

The US Navy needs 1377 F-18 Hornets. Each has a maximum speed in excess of Mach 1.8.

Optica

The Optica, designed by John Edgley was, perhaps, the oddest participant in the Show. The Bug-eyed EA7 Optica made its first flight from Cranfield Institute of Technology last Summer. It is designed to be used as a three seat observation aircraft. The cabin is mounted in front of the engine, a 180 HP Lycoming IO-360, which drives a ducted propulsor instead of a conventional propellor. The floor area can be modified to carry vertical mounting cameras. It is claimed to be a quiet machine both inside and outside. From the ground, it was certainly one of the quietest craft in the display.

Cosmic Traffic Jam

We've always thought of space as limitless. However, it is most useful to place a satellite in a geostationary (or geosynchronous) orbit about the equator. That is, the satellite appears to be stationary in the sky — it is orbiting as fast as the Earth is turning. That particular orbit is now becoming overcrowded. Looking towards the 1990s, NASA is carrying out research into new telecommunciations techniques to allow fewer satellites to carry greater workloads. In future, tracking and data relay satellites will also replace some ground stations.

NASA may co-operate with the European Space Agency (ESA) to fly a satellite to Halley's comet. ESA is committed to sending the satellite and has offered NASA experimental space on-board. NASA may provide the launcher.

Indoors

NASA, ESA, satellites...in fact spaceflight in general constituted a very small part of the Show. The two spacious exhibition halls were packed with just about everything with anything to do with aviation and avionics. The main feature of Plessey's stand in the North Hall was a new, fully-equipped production version of a Transportable Air Defence Processing and Control Cabin. It houses the signal processing equipment and displays for the Plessey AR3D Long Range Radar system. The Radar and P & C Cabin provide ground forces with a mobile, autonomous radar command and control post capability. The post can automatically track 40 aircraft and carry out eight interceptions. The AR3D's electronic countermeasures can also be selected.

Ferranti announced the development of a miniature inertial navigation system (FIN2000) for use in military aircraft. Positional data is presented to the pilot on a control and display unit and is typically accurate to within 1 nm/hr of operation. The modular system features extensive built-in test and self-calibration facilities for easy maintenance and enhanced reliability. Pre-production models will shortly begin flight trials at the Royal Aircraft Establishment. **ETI**

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See also A250 on opposite page

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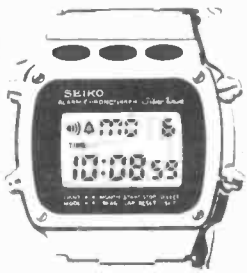

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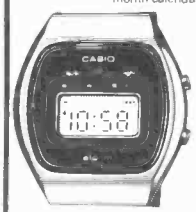

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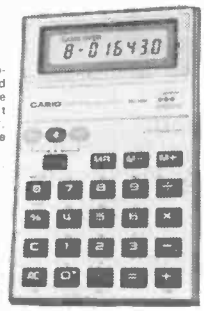

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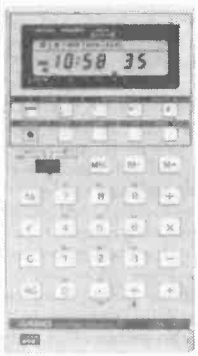

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METRONOME

A PROJECT FOR YOUR FREE PCB

We couldn't design five projects for our free Multi-Option Board without one based on the versatile 555. Circuit design by Keith Brindley

The 555 is such an adaptable integrated circuit that no home can afford to be without at least one. As a timer IC it does its job magnificently, working in a variety of monostable and astable multivibrator modes with just a handful of additional passive components, and its timing period is adjustable from literally just a *fraction of a fraction* of a second through to *hours*, simply by selection of one resistor and one capacitor.

Metro Gnome

Our chosen design using the 555 is a metronome. Before the advent of relatively cheap solid-state electronic components such devices were clockwork. Because of this they had a tendency to start off at a high speed and as the spring slowly wound down they got slower and slower. A completely electronic metronome does not suffer from this problem and yet can be far cheaper than a clockwork counterpart.

The circuit is simply an astable multivibrator. Increasing either the resistors or the capacitor values, or both, the timing period can be lengthened, decreasing the frequency and vice versa.

Applications

At audio frequencies, ie 30 Hz to 16 kHz, the 64R loudspeaker is an adequate transducer, but outside this range other transducers can be utilised to suit. For instance, if the frequency of the astable is increased to 40 kHz by choosing suitable component values and the loudspeaker replaced by an ultrasonic transducer, then the circuit can be converted into an ultrasonic transmitter. It couldn't be simpler.

Combinations

You could use the astable as a clock generator for digital circuits, or you could combine this circuit with that of the 2 W Power Amplifier to make a loud siren. The choice is yours.

Construction

None of the components are at all critical and if you can't obtain exactly the right component value, don't worry. Anything remotely close to the specified values will get your device off the ground and operational.

If your capacitor value is too high, simply use a lower value resistor combination and vice versa. Six links are required to complete the circuit, then you can connect your battery and go.

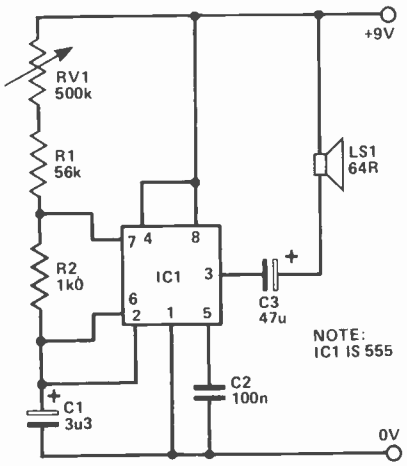


Fig.1. Full circuit diagram of the Multi-option Metronome.

HOW IT WORKS

The circuit is a standard 555 astable multivibrator which means that the device operates in a free run oscillating mode and the output from pin 3 is constantly switching between 0 V and 9 V at a rate determined by the components in the circuit. This switching output is coupled to the loudspeaker via C3.

The multivibrator mark/space ratio is deliberately kept uneven to provide short, sharp pulses to the loudspeaker, instead of the more usual square-wave normally associated with an astable. This, of course, produces a more pronounced click from the speaker to duplicate the tick of the metronome.

The mark/space ratio is adjusted by changing the values of RV1 and R1 along with R2. Capacitor C1 charges up toward supply voltage through RV1, R1 and R2 and the output of the 555 is low for this period. When the voltage at pin 6 (ie the voltage across this capacitor) reaches approximately two-thirds supply an internal switch operates, sending the output high. In going high, the output takes pin 7 to 0 V internally, which discharges the capacitor through R2 only. When the capacitor voltage falls to about one-third supply, the internal switch changes state again to take the output low. This action repeats itself ad infinitum.

From this you can see how different mark/space ratios are possible — the charge rate (off time) must be greater than the discharge rate (on time) by the ratio:—

$$\frac{RV1 + R1 + R2}{R2}$$

For example, with RV1 in minimum position the ratio is:

$$\frac{56k + 1k0}{1k0} = 57:1$$

In other words the off time is 57 times as long as the on time.

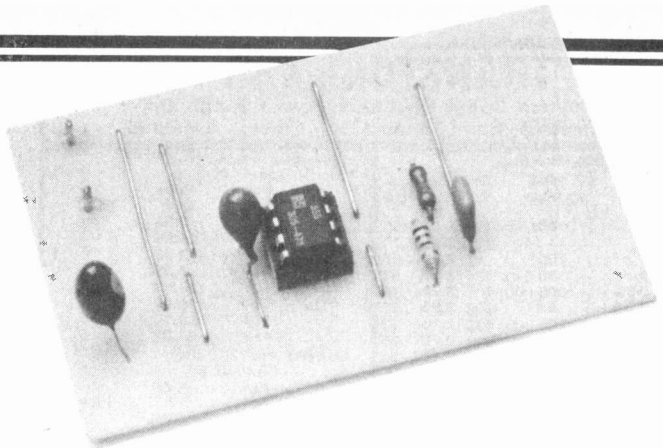
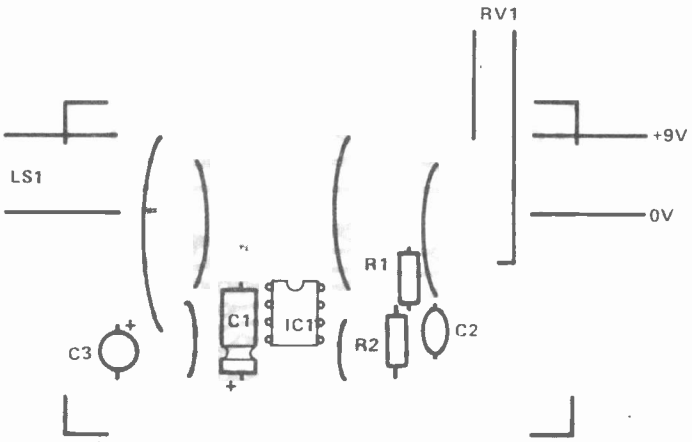


Fig.2. Component overlay for the Metronome. For once you'll have to ignore the unused locations on the PCB.



BUYLINES

The ETI Multi-Option Board Metronome uses standard components, readily available from suppliers advertising in this issue.

PARTS LIST

Resistors All ¼ W, 5%	
R1	56k
R2	1k0
Potentiometers	
RV1	500k linear
Capacitors	
C1	3u3 10 V electrolytic
C2	100n ceramic
C3	47u 10 V tantalum
Semiconductors	
IC1	555
Miscellaneous	
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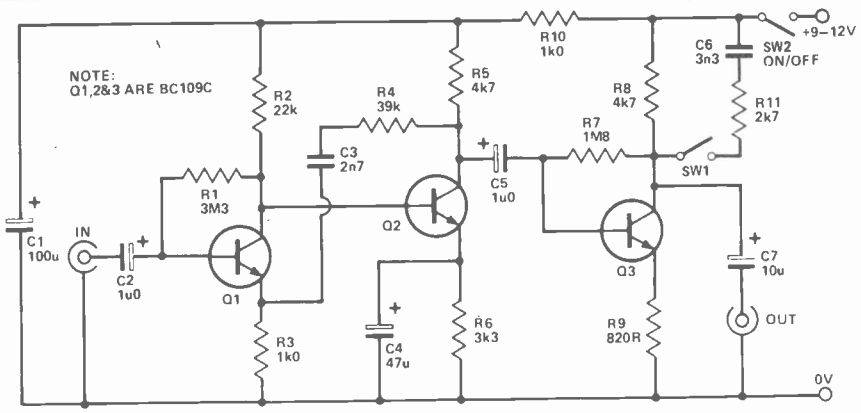


Cassette Preamplifier

Used in conjunction with one of the cassette mechanisms currently available on the surplus market (or a mechanism removed from an old recorder or player) this preamplifier circuit makes an inexpensive but useful cassette player for use with a hi-fi system. The circuit is for a mono player, but for a stereo unit it is, of course, merely necessary to make one preamplifier for each channel.

The output signal level from a cassette tape head is typically about 500 uV or so at middle audio frequencies for a mono head and only about half this level for a stereo type. The preamplifier must, therefore, provide a considerable amount of voltage gain in order to match this to a hi-fi amplifier, since these require a signal level of about 1,000 times higher than this. It is also necessary for the preamplifier to provide equalisation, because the output from a tape head rises with frequency at a rate of 6 dB per octave. However, at higher audio frequencies tape heads are not very efficient and require a much lesser degree of roll off.

Q1 and Q2 are used in a conventional two stage, direct coupled, common emitter amplifier and the frequency-selective negative feedback through C3 and R4 provides the appropriate equalisation. These also set the midband voltage gain of the input stages at about 46 dB (200 times). With such a low input signal level it is obviously necessary to use low noise transistors (such as the BC109C) in order to obtain good results. Running Q1 at a low collector current of about 200 uA also helps to give a low noise level.

Q3 is used as a low gain common emitter stage, which provides the additional amplification needed to give a suitably high output level. R9 introduces negative feedback, which controls the voltage gain of Q1 and the specified value gives a gain of about 14 dB (five times). For a stereo unit R9 should be reduced to 390R in order to give increased gain to compensate for the lower output of a stereo tape head.

When playing a Dolby B encoded cassette SW1 can be closed. This gives a small degree of treble cut which provides a reasonably flat overall response, with a small excess of treble at low signal levels and a slight deficit at the highest levels. A useful level of noise reduction is obtained, although only about half that provided by a proper decoder.

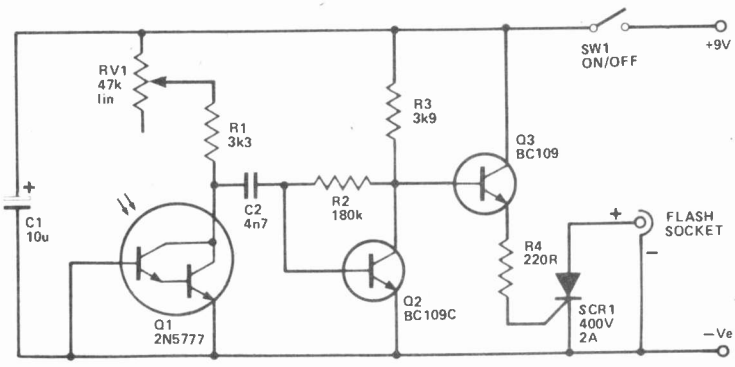
The circuit is capable of excellent results and the output quality is largely dependent on the quality of the tape head, the tape used in the cassette and so on.

Flash Slave Unit

The photocell used in this circuit is a photo-Darlington transistor. This gives a fairly fast operating speed and high sensitivity. In fact the sensitivity is rather too high, making it likely that the cell would saturate in only moderately light conditions. Its base terminal is, therefore, connected to the negative supply rail to give a suitable reduction in sensitivity. R1 and RV1 form the collector load resistance for photocell Q1 and RV1 acts as a sensitivity control. With RV1 at a low resistance, the increase in the current passed by Q1 when it picks up the pulse of light from the primary flashgun will produce a fairly small voltage spike across the load resistance. With RV1 set at a high resistance, a similar current pulse would produce a much larger voltage spike across the load and high sensitivity is obtained.

One problem with equipment of this type is that under bright conditions the photocell can saturate, preventing the circuit from functioning. When used indoors, saturation is unlikely to occur even with RV1 set for maximum sensitivity. The sensitivity of the unit should be so high that it will trigger reliably even if the primary flashgun and Q1 are aimed in opposite directions. When used outside in bright conditions it would be advisable to back off RV1 and the aim of Q1 and the flashgun will inevitably be more critical (there will probably be less reflected light to trigger the unit in addition to the reduction in sensitivity).

C2 couples the output from Q1's collector to the input of a common emitter amplifier using Q2. This is biased by R2 so that there is a quiescent collector voltage of only about 1 V. Q3 is an emitter



follower buffer stage which is used to drive the gate of SCR1 from Q2's collector. The quiescent voltage at Q3's emitter is insufficient to activate the thyristor, but when Q2 receives the negative voltage spike from Q1 it switches off and the emitter potential of Q3 rises to a high enough level to trigger SCR1 and fire the second flashgun. R4 is a current limiting resistor which prevents Q3 from passing an excessive current.

The current consumption of the circuit is about 2 mA. Note that the flash lead must be connected to SCR1 with the correct polarity or the unit will not operate.

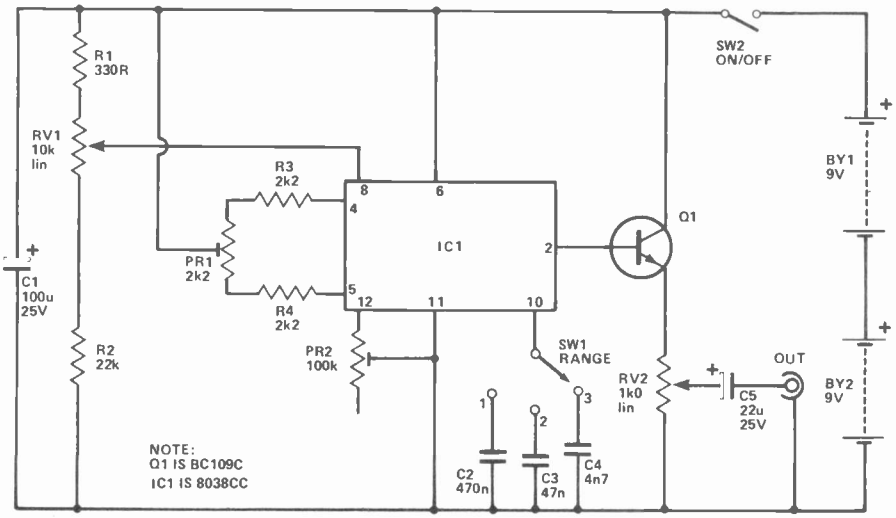
AF Signal Generator

Although the 8038CC is not capable of generating an extremely pure sinewave, it is capable of producing an output of high enough quality for general audio testing. The simple circuit shown here covers the audio frequency spectrum in three ranges — less than 20 Hz to more than 200 Hz; less than 200 Hz to more than 2 kHz; less than 2 kHz to more than 20 kHz. The output amplitude is continuously variable up to a maximum of about 550 mV RMS and is from a low impedance source.

The 8038CC oscillates by first charging a capacitor via a constant current source and then discharging it through another constant current generator. It thus generates a triangular waveform. This is then fed to a trigger circuit to generate a squarewave signal and to a non-linear amplifier which "rounds off" the signal to give a sinewave output of reasonable purity. C2 to C4 give the three ranges. R1, RV1 and R2 form a potential divider circuit, which is used to control the charge and discharge currents of the timing capacitor. RV1 thus acts as the fine frequency control. PR1,R3,R4 balance the charge and discharge currents, so that a symmetrical output is obtained. PR2 is part of the sinewave shaping circuitry and is adjusted for maximum purity.

The sinewave output at pin 2 of IC1 is at a high impedance and is, therefore, coupled to the output via an emitter follower buffer stage using Q1. RV2 is the output level control, and C2 provides DC blocking at the output. Current consumption is approximately 9 mA.

With the unit adjusted for a fairly low frequency output (about 50-200 Hz), it should be possible to hear the main fundamental frequency plus the higher frequency harmonic signals. The output can be monitored using a crystal earphone or amplifier/loudspeaker. PR1,2 are adjusted to minimise the harmonics.



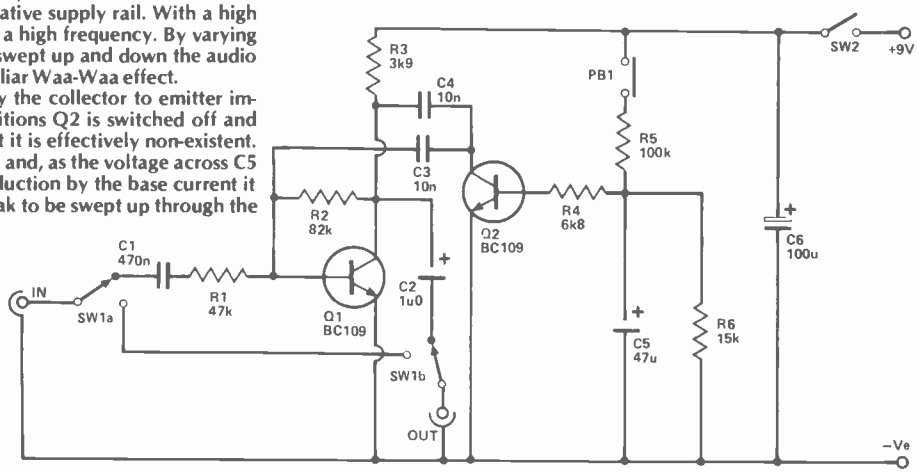
Waa-Waa Unit

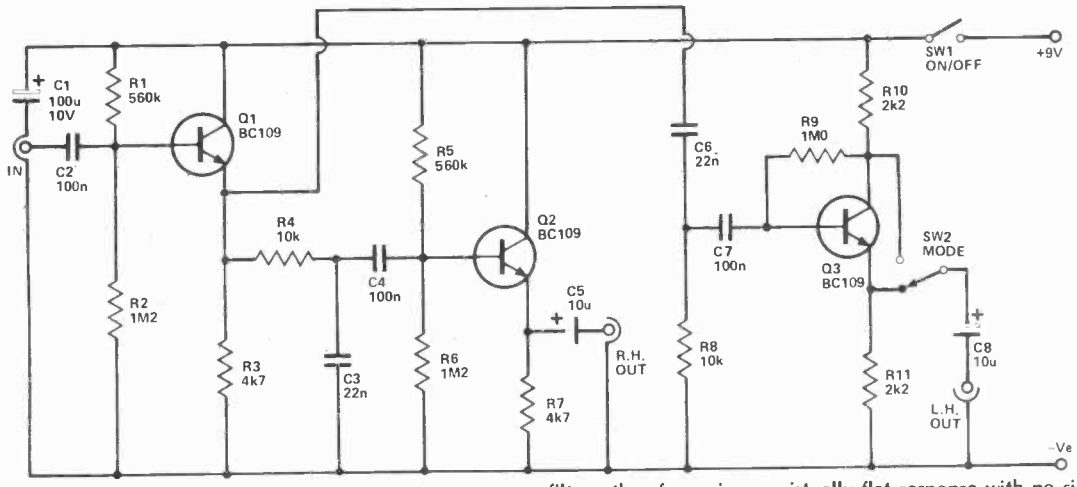
An unusual feature of this circuit is that the Waa-Waa effect is obtained by operating a foot-switch, rather than the more usual method of operating a potentiometer via a pedal mechanism. This method is slightly less versatile than a proper Waa-Waa pedal, but is far simpler for the home constructor to build since it avoids the need for any pedal mechanics.

The basic Waa-Waa circuit uses a quite conventional arrangement based on common emitter amplifier, Q1. Frequency selective negative feedback is provided by C3, 4. These provide little feedback at a certain frequency. A peak in the response of the amplifier is produced at this frequency, as the lack of feedback enables virtually the full voltage gain of Q1 to be realised. The actual frequency at which the peak is produced can be controlled by means of a resistance between the junction of C3, 4 and the negative supply rail. With a high resistance here the peak is produced at a high frequency. By varying the control resistance the peak can be swept up and down the audio frequency spectrum, producing the familiar Waa-Waa effect.

The control resistance is formed by the collector to emitter impedance of Q2. Under quiescent conditions Q2 is switched off and the peak is at such a low frequency that it is effectively non-existent. If PB1 is operated, C5 charges up via R5 and, as the voltage across C5 increases, Q2 is biased harder into conduction by the base current it receives through R4. This causes the peak to be swept up through the audio band until C5 becomes fully charged. If PB1 is then released, C5 gradually discharges through R4, Q2 and R6, causing the bias on Q2 to decrease and the peak to be swept down the audio spectrum. Thus the required effect is produced by closing and opening PB1. The Waa-Waa frequency is partially controlled by the frequency at which PB1 is operated, but C5 restricts the range of frequencies that can be obtained in practice. However, the value of C5 can be altered to suit individual requirements, or several switched components of different values could be used.

SW1 enables the Waa-Waa circuit to be quickly and easily bypassed. R1 is needed to reduce the gain of the unit which would otherwise be excessive. Current consumption is about 2 mA.





Stereo Synthesiser

There are two common methods of producing a pseudo stereo effect from a mono signal; playing the mono signal from the two speakers in antiphase and the use of frequency selective techniques, which normally consists of directing lower frequency signals into one channel and higher frequency signals into the other. This circuit uses the second technique, but can additionally give antiphase signals which can give a better effect, especially when using headphones.

Q1 is used as an emitter follower buffer stage which ensures that the two filter networks fed from its output are driven from a low impedance source. If these were driven direct from the input, it is quite possible that they would be fed from a source impedance of a few kilohms or more, which would be quite sufficient to alter their effective characteristics.

The two filters are formed by R4 and C3 (low pass), and C6 plus R8 (high pass). A high roll off rate is by no means essential in this application and the 6 dB per octave attentuation rate of simple RC filters such as these is perfectly adequate. The −3 dB point of each filter is at approximately 800 Hz and the combined output of the filters, therefore, gives a virtually flat response with no significant peaks or troughs.

Q2 is connected as an emitter follower buffer stage and this ensures that there is minimal loading on the low pass filter. Q3 similarly ensures that there is minimal loading on the high pass filter, but this device is used as a phase splitter. With SW2 switched to take the output from Q3's emitter, Q3 effectively operates as an emitter follower and gives no phase inversion. With SW2 switched to take the output from Q3's collector, Q3 then effectively acts as a common emitter stage with 100% negative feedback (and unit voltage gain) due to R11. It also provides a 180° phase shift so that the two output signals are in anti-phase. An in-phase relationship is needed to give a good central stereo image and the use of anti-phase signals tends to give an impression of increased channel separation.

In a stereo orchestral recording it is normal for the violins to come from the left hand channel, with the cellos and basses from the right hand channel. Therefore, the high frequency signals are fed to the left channel and the low frequency signals are fed to the right channel so that the unit provides a similar effect (although it will obviously function properly with the outputs connected either way).

The current consumption of the circuit is about 3 mA.

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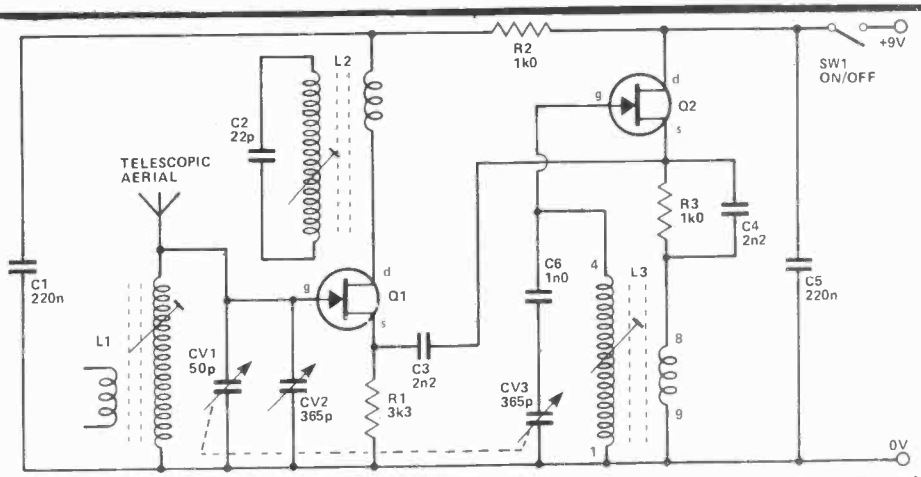

NOTE:
Q1 & 2 ARE BF244B
T1 IS DENCO D.P. BLUE AERIAL COIL, RANGE4
T2 IS DENCO MW5FR FERRITE AERIAL
T3 IS DENCO WHITE OSC COIL, RANGE 4

Short Wave Converter

This SW converter tunes over 5 to 15 MHz approximately and also enables an ordinary MW broadcast receiver to pick up stations operating on the 19, 25, 31, 41 and 49 m broadcast bands.

Signals picked up by the telescopic aerial are directly coupled into the aerial tuned circuit as these signals will be quite weak, necessitating a tight coupling. CV2 is the main tuning capacitor for the aerial tuned circuit and CV1 is the aerial trimmer control. The signals selected by the tuned circuit are coupled directly into the gate of mixer transistor Q1, no coupling winding being needed here due to the use of a JFET transistor with a very high input impedance. The drain load for Q1 is a MW ferrite aerial, but it is used in reverse in this application and is used to radiate the 1.6 MHz IF output of the converter. This is picked up by the MW radio, which is placed near the converter and tuned to a quiet spot on the band in the vicinity of 1.6 MHz. The position of the coil on the ferrite aerial is adjusted to resonate L2 at the appropriate frequency and effect optimum signal transfer.

The oscillator uses JFET device Q2 in the source follower mode, with positive feedback provided by L3. At the resonant frequency of L3 there is sufficient feedback to cause oscillation and CV3 tunes the oscillator over a frequency range which is 1.6 MHz higher than the range of the aerial tuned circuit so that the required difference frequency of 1.6 MHz is produced at the output. C6 is a padder capacitor which gives reasonably good tracking between the aerial and oscillator circuits. Perfect tracking is not required since CV1 can be used to keep the unit peaked for optimum results. C3 is used to couple the output from the oscillator to the input of the mixer stage. The circuit has a current consumption of only 4 mA.

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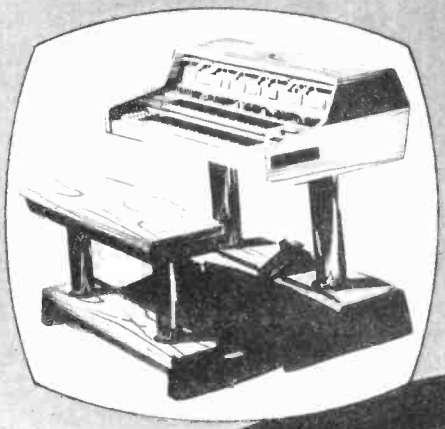

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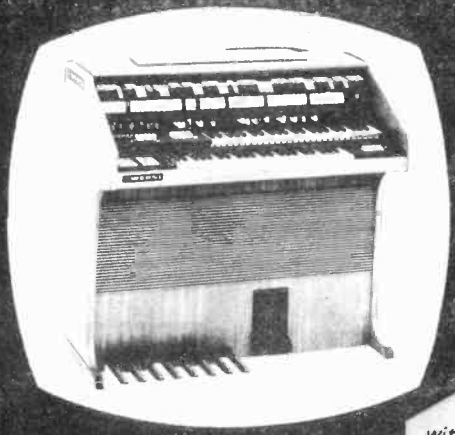

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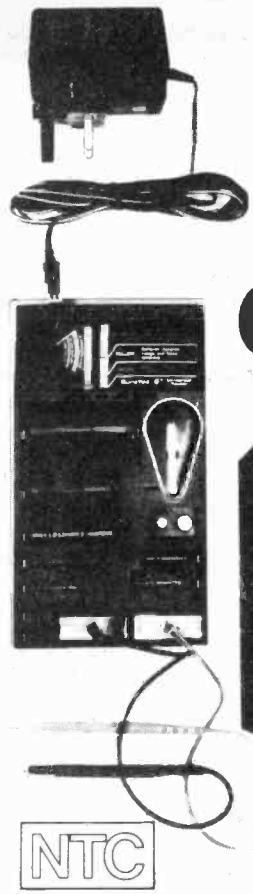

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LFM 39A	Wow/Flutter Meter (Dim)	£299.00
LAV 191	Audio Tester	£249.00
LAG 125	Low Distortion Audio Generator	£229.00

GENERAL TEST GEAR

LCR 740	LCR Bridge	£135.00
LTC 906A	Transistor Checker	£ 90.00
LVT 72	Fet Transistor Checker	£119.00
LTC 907	Transistor Checker	£139.00
LAT 47	Attenuator	£135.00
LAT 45	Attenuator	£ 75.00
LFG 1300	Sweep/Function Generator	£299.00

AMATEUR RADIO

LOM 815	DIP Meter	£ 43.00
LIM 870A	Antenna Impedance Meter	£ 41.00
LPM 880	RF Power Meter	£ 69.00
LPM 885	SWR/Watt Meter	£ 44.00
LAC 895	Antenna Coupler	£ 85.00
LAC 896	Antenna Coupler	£ 41.00
LAC 897	Antenna Coupler	£ 41.00

Please send large SAE for special catalogue. All prices exclusive VAT/carriage.

The new Marshall's 80/81 catalogue is now available. A veritable treasure house of components, test gear, tools, etc.

Lots of old friends, but also many new products including leader test gear, Crimson Hi Fi Modules, Rechargeable NI Cad batteries and chargers (very competitive). More components including SN74ALS series, new tools etc. Available by post, UK 75p post paid: Europe 95p post paid; Rest of world £1.35 post paid.

SINCLAIR INSTRUMENTS

Digital Multimeter

PDM35	£	34.50
" " DM235	£	52.50
" " DM350	£	72.50
" " DM450	£	99.00

Digital Frequency Meter
PFM200 £ 49.80
Low Power Oscilloscope
SC110 £139.00

NEW
TF200 Frequency Meter £145.00
TGF105 Pulse Generator £ 85.00

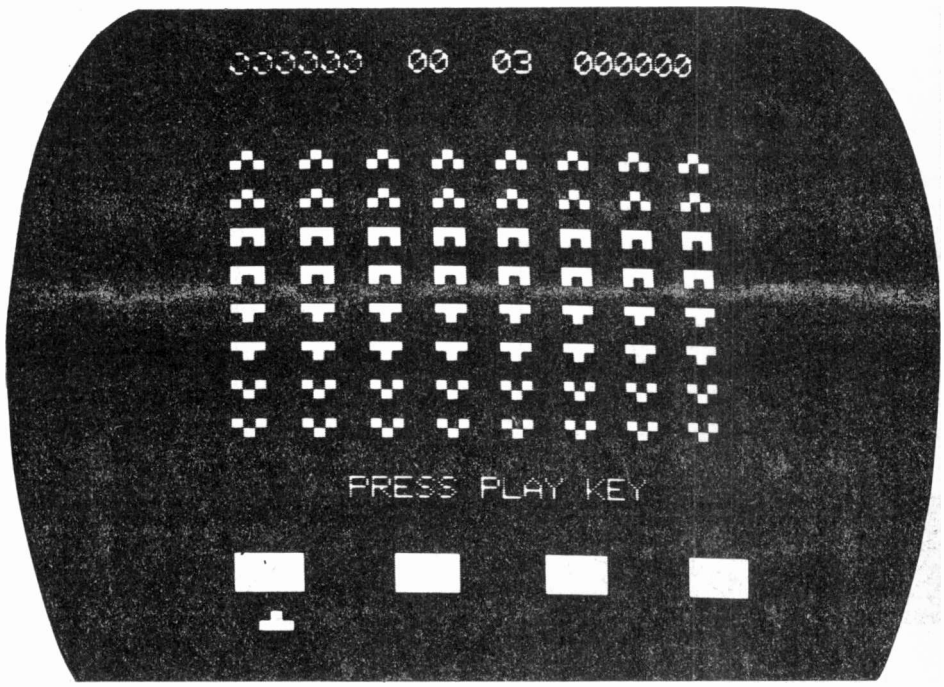
CRIMSON ELEKTRIK HI FI MODULES

CE608	Power Amp	£20.09
CE1004	" "	£23.43
CE1008	" "	£26.30
CE1704	" "	£33.48
CE1708	" "	£33.48
CPS1	Power Unit	£19.52
CPS3	" "	£23.52
CPS6	" "	£30.00
CPR1	Pre Amp	£32.17
CPR1S	Pre Amp	£42.52

All Prices + VAT + postage/packaging

Don't forget! We also carry an impressive range of semi-conductors, passive components, electro mechanical components, tools etc.

SPACE INVASION GAME



You've heard of the beer you drink at home — now ETI is doing its bit to clear the pubs with the Space Invasion game you play at home. Will the social life of England ever be the same?

Hardware design by Paul Johnson. Software by Mike Rose.

One of the fastest growth industries of the last few years must be the production of video games. Only a couple of years ago we were pushing our five pence coins into the slot to play what was laughingly known as tennis (two oblong 'bats' and a blob that bounced all over the screen). Nowadays we can pilot starcruisers into the uncharted depths of space and zap the enemy with laser bolts, launch rescue missions to the Moon, and engage in dogfights with agile aliens who can fly rings round a cathode ray tube. Of course it costs more than fivepence too! Video games have probably led the field in showing the public that the microprocessor is capable of better things than frightening Clive Jenkins.

Life would be a lot better if you didn't have to keep feeding the coin slot to stay in practice, though, and as usual ETI comes to the rescue. Yes, for the first time anywhere we present a home-built version of the country's most popular pastime (all right, second most popular). Before you glance across to Buylines and decide we've got peculiar ideas about how to save you money, it should be pointed out that you get more than just a TV game. A TV game requires a microprocessor, some memory, a graphics generator, a keypad and a UHF output suitable for plugging into your television set. Amazingly enough these are also what you need for a home computer. Once you have the basic Space Invasion game, you can expand it at very little expense into just such a computer, designed by Tangerine Computer Systems.

Playing the Game

The game follows a fairly standard format. Eight columns of eight saucers fly backwards and forwards across the TV screen and slowly descend while you take potshots at them from your laser base at the bottom of the screen. The base may be moved to left and right to aim at the enemy and to dodge the bombs they are dropping on you. If they hit you, your base is destroyed, but there are defences for you to hide under — these are gradually whittled away by the alien barrage. (Your laser bolts can cancel bombs as they fall.) Everything gets faster as the number of aliens decreases, and when they've all been wiped out, lo! another fleet appears.

Scoring is as follows: Top two rows — 50; Next two — 40; Next two — 30; Bottom two — 20. Every time you blast a saucer, its score is added to your total. Occasionally a huge saucer flies across the top of the screen; it doesn't drop bombs and hitting it scores 100 points. There are four numbers displayed at the top of the screen, and from left to right they are: score this game, number of saucers left on screen, number of bases you have left and highest score during this session. You start off with three bases and are awarded an extra one for every two thousand points, but you can't have more than four at once.

The switches are provided to select one of four levels of difficulty — these are set to either 0 V or 5 V and provide a binary input, 00 for easiest level (slow) and 11 for expert (very fast).

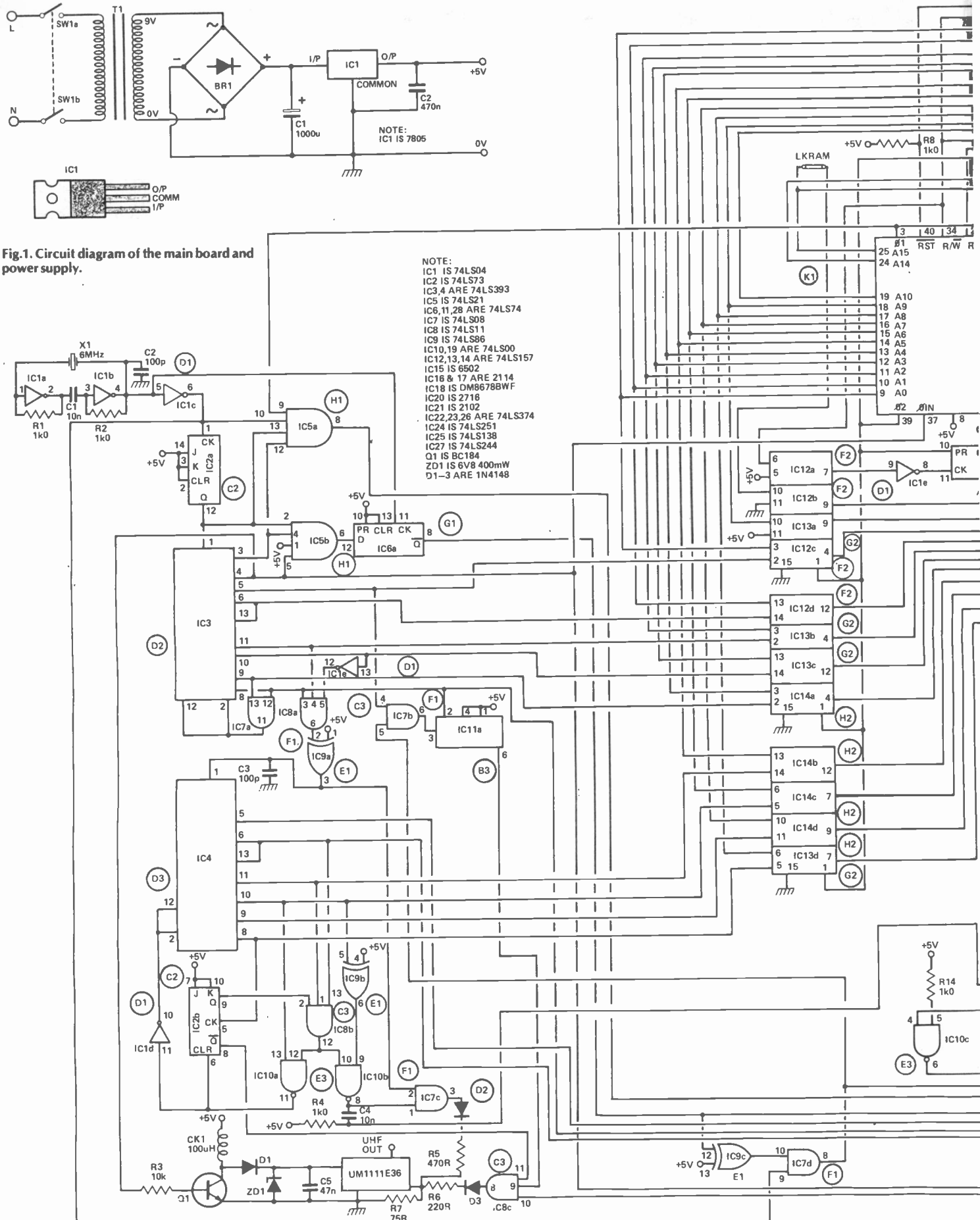
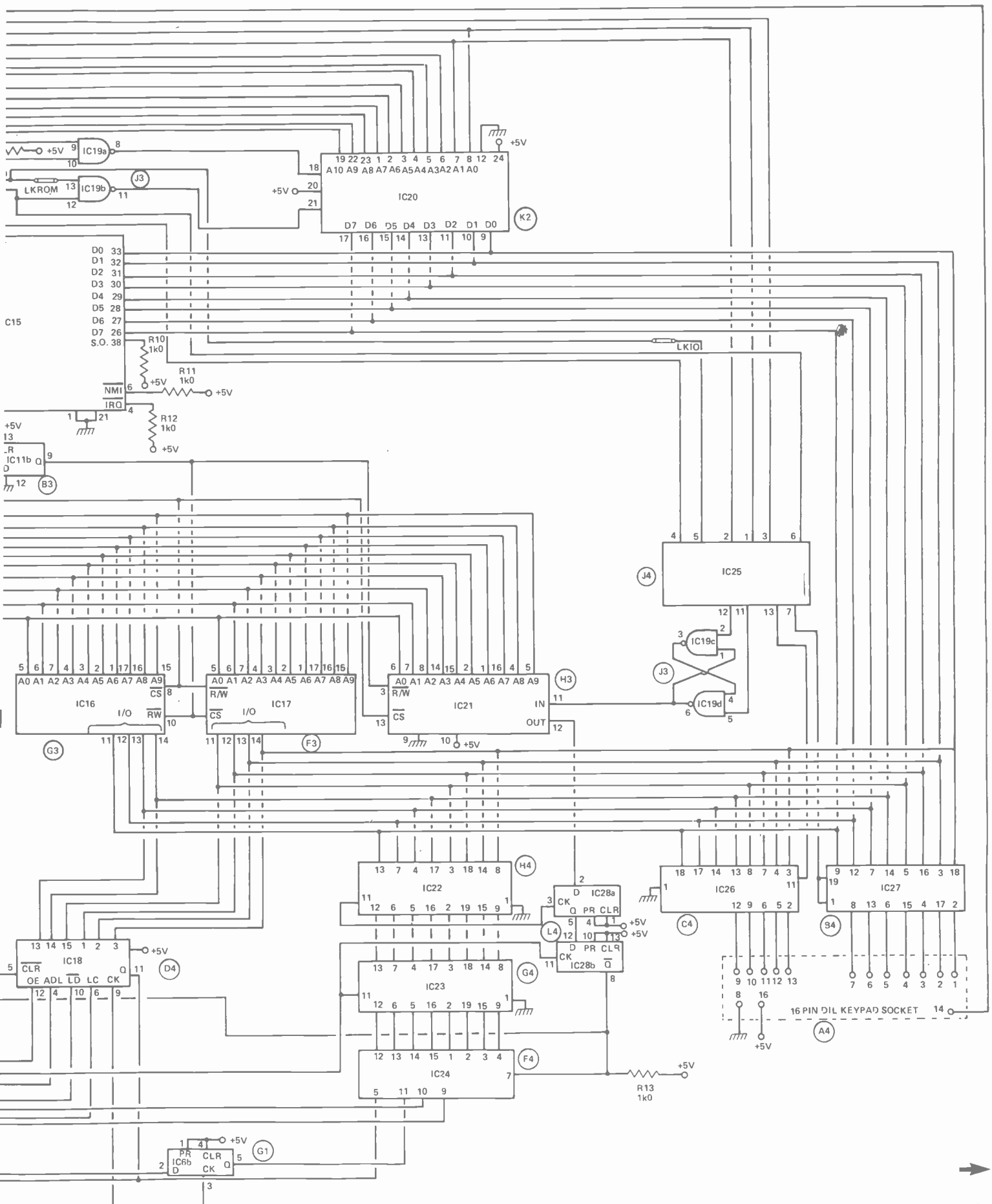
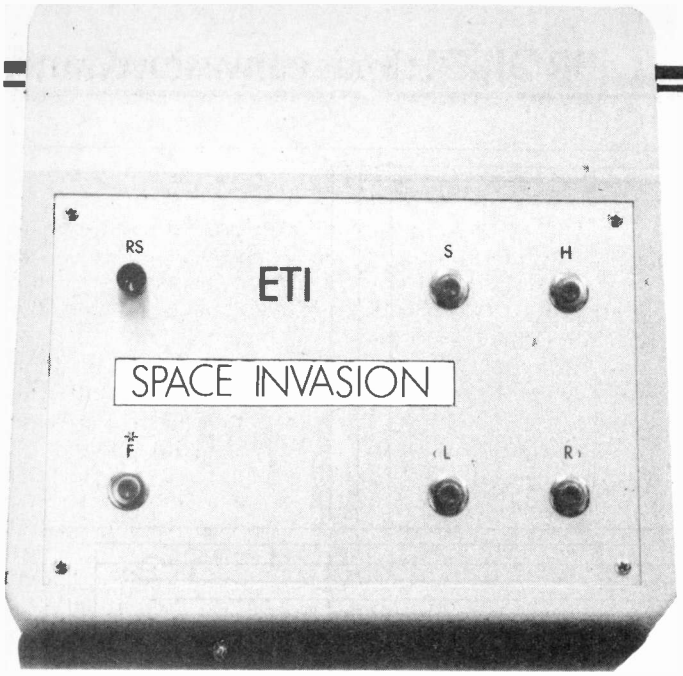


Fig.1. Circuit diagram of the main board and power supply.


IC19a
IC19b
LKROM
IC20
A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
D7 D6 D5 D4 D3 D2 D1 D0
D0 33
D1 32
D2 31
D3 30
D4 29
D5 28
D6 27
D7 26
S.O. 38
C15
R10 1k0
R11 1k0
R12 1k0
NMI
IRQ
LKIO
IC11b
IC25
IC19c
IC19d
IC16
IC17
IC21
I/O
R/W
CS
IN
OUT
IC22
IC23
IC24
IC18
IC26
IC27
IC28a
IC28b
CLR
OE ADL LD LC CK
16 PIN DIL KEYPAD SOCKET
R13 1k0
+5V
J3
J4
K2
B3
G3
F3
H3
H4
G4
F4
L4
D4
C4
B4
A4
G1



The face of the Space Invasion. The simple controls are reset, start (play), hold, fire, left and right.

HOW IT WORKS

Although the circuit diagram looks hideously complex, it falls quite naturally into various basic blocks which can be examined separately. The heart of the system is IC15, a 6502 microprocessor. This can be seen at top centre of the circuit, surrounded by its memory and address decoding chips. Below these are the chips that generate the graphics for the display. The I/0 port for connecting the main board to the keyboard and sound generator circuitry is on the right. Finally, the entire section on the left produces the timing signals required by the microprocessor, as well as all the synchronising signals which must be mixed with the video information before it is passed to the UHF modulator.

The master oscillator is formed by three of the inverters in IC1; the frequency of operation is set at 6 MHz by crystal X1, IC2, IC3 and IC4 form the complete counter chain for generating all the timing signals and refresh addresses — the various additional gates and flip-flops decode the counter outputs to provide these signals as follows.

IC3 is reset by the output of IC7a; this controls its count length. Three of the outputs of IC3 are decoded by IC8a and IC9a to produce the line sync pulse, which also clocks the line counter IC4. The line blanking pulse is produced at pin 6 of IC11a. The count length for IC4 is controlled by the reset pulse derived from IC10a, and IC10b produces the frame sync pulse. The frame blanking pulse is produced at pin 8 of IC2b. The frame sync and line sync pulses are mixed in IC7c; the frame blanking and line blanking pulses are mixed in IC8c with the video information from the character generator circuitry.

The timing signals for loading the character generator IC18 are produced by IC5 and IC6.

The line blanked and frame blanked video is mixed with the sync pulses by diode 'OR' gate D2, D3. R5, R6 and R7 ensure that the various parts of the composite signal have the correct relative amplitudes before being fed to the input of the UHF modulator. The modulator requires a supply voltage higher than the 5 V that powers the other circuitry — this is derived from chopper transistor Q1 which is driven by one of the outputs of counter IC3. D1, ZD1 and C5 regulate the voltage from Q1 collector to 6V8.

IC12, IC13 and IC14 form the address and control signal selector for the memory. This switches over at the processor clock rate and allows both screen refresh and microprocessor access to occur at full speed without mutual interference. IC20 is the ROM chip; the RAM is provided by IC16, IC17, and IC21. The data output of the RAM is processed by IC22, IC23 and IC24 to produce the graphic pixel cells. IC28 selects either graphics or alphanumeric mode for a particular character cell position.

IC26 and IC27 provide the I/0 port to read the paddle switches and drive the sound generator.

A unique feature of this game is the provision of a hold switch. If you want to go to the loo, or answer the phone, you can freeze the action in the middle of the game and carry on where you left off when you get back.

Objects and Computers

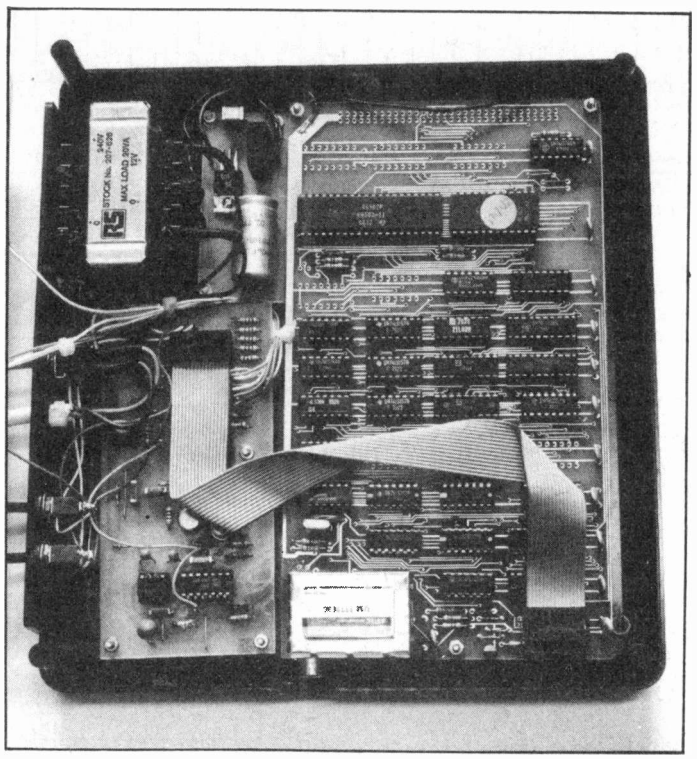
The object of the game is to score 999,999 points! If you manage it a suitable message appears on the screen but we're not going to tell you what it is — play the game and find out for yourself, if you can. You lose if:

1) You lose all your bases before reaching 999,999;
2) An invader touches your laser base;
3) An invader lands on the baseline.

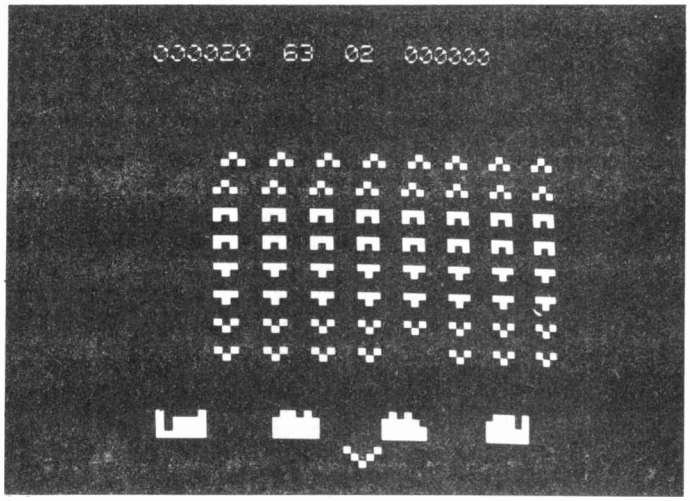
If you already own a Microtan 65 computer than it isn't necessary to build all the hardware for this project — you simply run the Space Invasion software on your existing machine. Sound effects are optional and require the additional circuitry shown in the diagram. The special hardware may be added by connection to the cable socket. All the possible configurations for getting Invasion onto your TV screen are given below.

1) Invasion PCB + Hex keypad + Invasion PROM
2) Invasion PCB + special Key Unit + Invasion PROM
3) Microtan 65 + Tanex + Invasion PROM (in position E2) + Hex keypad
4) Microtan 65 + Tanex + Invasion PROM + special Key Unit
5) Microtan 65 + Tanex + 2K RAM + keyed-in software + Hex keypad
6) Microtan 65 + Tanex + 2K RAM + keyed-in software + Key Unit.

Note the use of a Hex keypad — this project will *not* run with an ASCII keyboard.



Inside the box, the main board is fitted into the right hand side, connected to the sound effects board on the left by ribbon cable. The power supply board is squeezed in next to the transformer. The two switches on the rear panel select the level of difficulty.



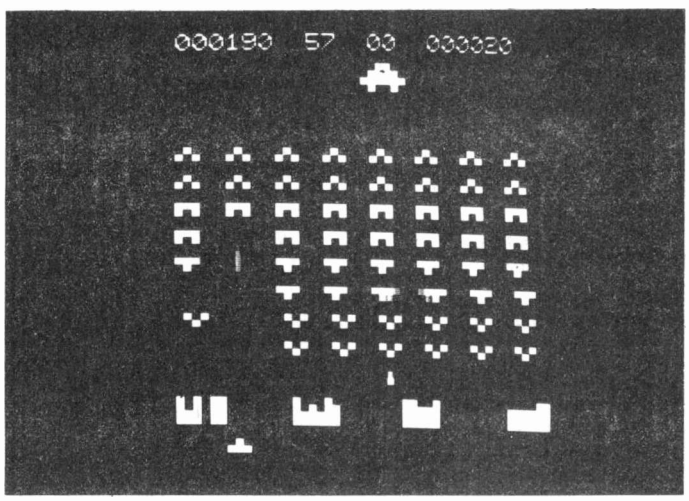
The screen display. This unfortunate space traveller has just been zapped by an alien.

Construction

Tricky bit first. The main board is double-sided but it isn't necessary to solder components on both sides because the holes are plated through (sighs of relief). Fit the links and the discrete components first, being careful with the polarity where necessary, then solder all the IC sockets in the positions shown in the overlay diagram. You'll find there are more spaces for sockets than there are sockets but don't panic — this is to allow for later expansion into a computer as mentioned earlier. The UHF modulator is fixed to the PCB by soldering the case tags to the large pads provided — make sure it's the right way round. Now, double-checking both device type and orientation very carefully, plug the ICs into their sockets. Fit two lengths of wire for the power supply connections (these solder directly to the copper track) and the main board is complete. Check it again.

Well, there's still a long way to go. We have a score of 480 with 49 aliens still coming and no bases left. But we did better than the last astrogamester. He only scored 20.

With a flying saucer zooming across the top of the screen, one alien has just launched a missile. Hit your left or right button quick! Or try to blow his (its) missile off the screen.



Operating Differences

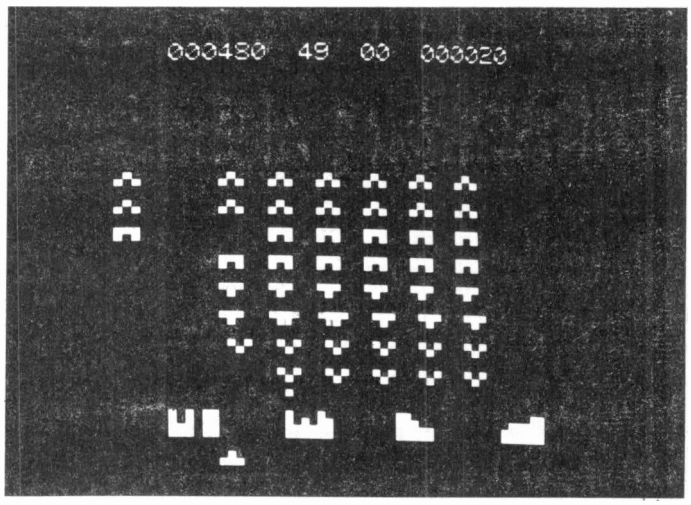
The UHF modulator for either version of the game is pre-tuned to Channel 36. Plug into the aerial socket, select a channel and adjust the tuning until the picture appears. If the game has been switched on without 'Reset' being operated, the screen will contain garbage.

If you are using the basic Invasion PCB, then operating the Reset switch brings the system into the 'ready-to-play' condition. If you are running the software on the Microtan 65, use Reset to gain access to TANBUG. The PROM is assembled to live at E800 (Hex), and the listing for the RAM version is assembled to live at 400 (Hex). So for the PROM version, typing GE800 brings the game to readiness by moving to the start address. With the software keyed into RAM, type G400.

If you are using the Hex keypad, the following keys are equivalent:

0 = PLAY
4 = BASE RIGHT
8 = BASE LEFT
C = FIRE
SHIFT = HOLD

Hitting any of the keys except HOLD removes hold.



Now you can sit in front of your telly and make your living room a safe haven for the human race. For details of the modifications to produce a home computer, watch this space!

BUYLINES

Tangerine Computers Ltd can supply the ETI Space Invasion project built for £99.85 all inclusive (or £80.85 in kit form). The sound generator and keypad section is available built for £20.55 all inclusive (or £15.38 in kit form).

If you want to shop around for your own components you can get the main Space Invasion PCB only for £21.15 all inclusive and the sound generator board for £5.60. The ROM is available for £17.75 all inclusive.

A case with internal PSU will be available from Tangerine soon. Contact them for the latest information on availability and price. Tangerine Computers Ltd, Forehill, Ely, Cambridgeshire.

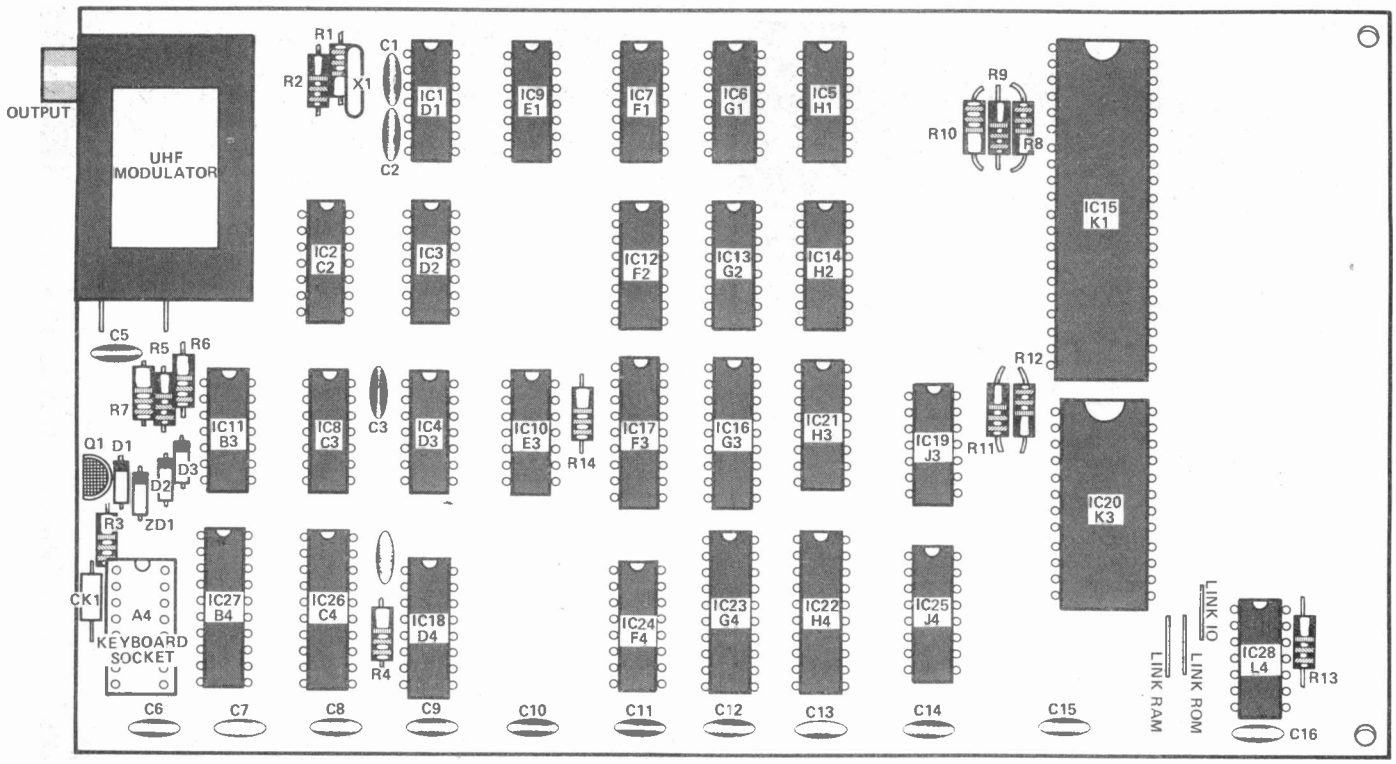


Fig.2. (above) Component overlay for the main board. All the chips face the same way.

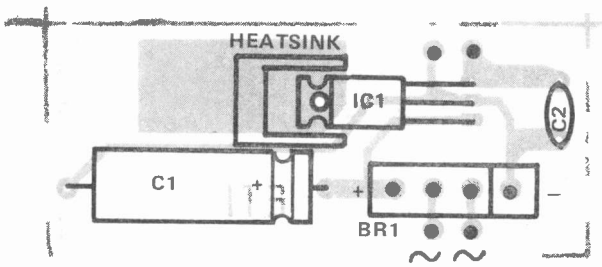


Fig.3. Component overlay of the power supply circuit. The heatsink is a type TV4, available from Watford Electronics.

PARTS LIST

Capacitors	
C1	1000u 25 V electrolytic
C2	470n polycarbonate
Semiconductors	
IC1	7805
BR1	1.6 A 'In-Line' package
Miscellaneous	
T1	0-9 V @ 1 A
SW1	DPDT miniature toggle
heatsink	

Next month, we conclude the ETI Space Invasion Game with constructional details of the sound effects board.

ETI

PARTS LIST

Resistors all ¼ W 5%	
R1,2,4,8,9,10,11,12,13,14	1k0
R3	10k
R5	470R
R6	220R
R7	75R
Capacitors	
C1,4	10n ceramic
C2,3	100p ceramic
C5,6-16	47n disc ceramic

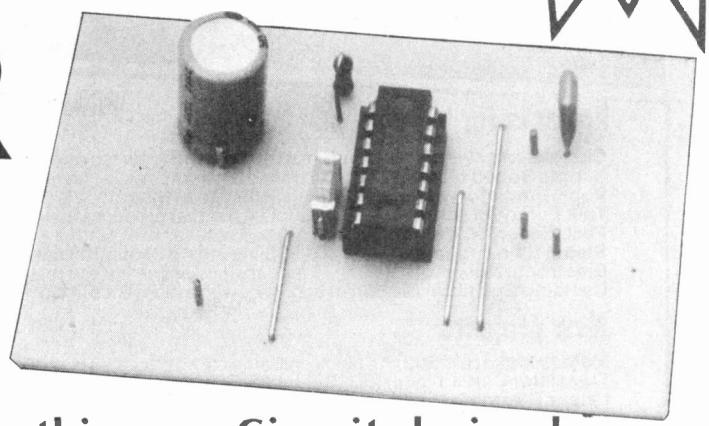
C6-16 are decoupling components, one for each column of ICs.

Semiconductors	
IC1	74LS04
IC2	74LS73
IC3,4	74LS393
IC5	74LS21
IC6,11,28	74LS74
IC7	74LS08
IC8	74LS11
IC9	74LS86
IC10,19	74LS00
IC12,13,14	74LS157
IC15	6502
IC16,17	2114
IC18	DM8678BWF
IC20	2716
IC21	2102
IC22,23,26	74LS374
IC24	74LS251
IC25	74LS138
IC27	74LS244
Q1	BC184
ZD1	6V8 400 mW
D1-3	1N4148
Miscellaneous	
CH1	100 uH choke
X1	6 MHz crystal
UHF modulator	UM1111E36

PCB, case, 14-pin DIL socket (x13), 16-pin DIL socket (x8), 18 pin DIL socket (x2), 20 pin DIL socket (x4), 24 pin DIL socket, 40 pin DIL socket.

A PROJECT FOR YOUR FREE PCB

2W POWER AMPLIFIER



This must be just about the simplest power amplifier that you're likely to come across — a few components and a free PCB. No excuses for not building this one. Circuit design by Keith Brindley.

If you need a simple-to-build, inexpensive power amplifier and you've got 15 minutes to spare, unpack your soldering iron and ETI Multi-Option Board. That's all it'll take to get your ETI 2 W Power Amplifer up and running.

We aren't claiming total originality for this circuit. The donkey work, of course, is all done by the well known and loved LM380 power amplifier IC. This chip eliminates the need for preset adjustments of any kind, and distortion and output noise are so low as to render the circuit virtually in the "High Fidelity" category.

Only four other components are needed to complete the amplifier, which will provide the builder with a fine device, needing only a power supply of between about 9-18 V DC (ideal for battery operation) to get things going.

For those interested in technical specifications, you'll want to know that the IC features an internally fixed gain of 50 (34 dB) and an output which automatically centres at half supply voltage. The output stage is short-circuit current-limited and thermal shutdown in the chip prevents overheating-to-damage point — it turns itself off if it runs a temperature, takes two aspirins and calls you when it cools off again. So, it's safe to assume that the amplifier is just about idiot-proof!

Construction

Nothing much to comment on here. It's all straightforward. Just make sure the chip is the right way round, as should be the power connections (shown on the overlay).

HOW IT WORKS

The whole IC can be regarded as a simple op amp with a power output stage tagged on at the end. Pin 2 is the inverting input and pin 6 the non-inverting input. To these can be added the usual feedback connections to tailor gain and frequency response as required, but internal resistors tie what would be the open loop gain to a flat ratio of 50. So with no feedback resistance, a fixed gain of 34 dB occurs whatever the input.

The output stage is a class AB, quasi-complementary pair, emitter-follower. This keeps crossover distortion to a minimum whilst also maintaining quiescent current at less than 15 mA. This latter fact allows satisfactory battery operation, with low distortion.

R1 and C2 form a Zobel network, which effectively suppresses a possible 5 to 10 MHz small amplitude oscillation which can occur during the negative swing into the load. Obviously the oscillations are not in the audio range nor will they pass through the speaker (due to coil reactance), but nevertheless they can cause power loss and other problems in an RF sensitive environment.

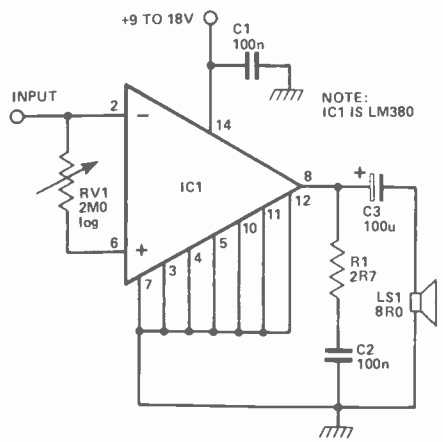


Fig.1 Circuit diagram. Pins 3,4,5,10,11 and 12 are joined internally.

PARTS LIST

Resistor ¼ W 5%	
R1	2R7
Potentiometer	
RV1	2M0 logarithmic
Capacitors	
C1,2	100n polycarbonate
C3	100u 16 V electrolytic
Semiconductor	
IC1	LM380
Miscellaneous	
LS1	8R0 Loudspeaker
ETI Multi-Option PCB	

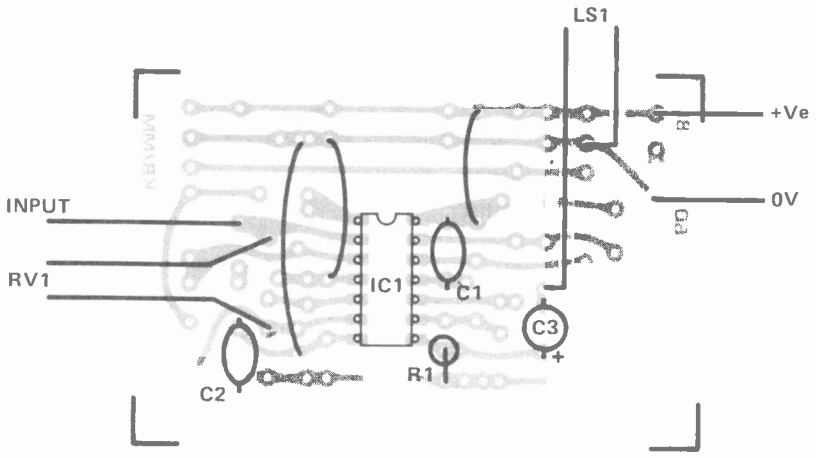


Fig.2 Component overlay.

BUYLINES

A simple project with few components. You shouldn't meet with any difficulty in obtaining the components. Have a look at the major suppliers advertising in this issue.

interface components

ALL PRICES ARE EXCLUSIVE OF VAT

TRANSISTORS

AC128	15p	BCY71	12p
AC187K	30p	BCY72	12p
AC188K	30p	BF179	25p
ACY17	90p	BF183	25p
AD149	55p	BF200	29p
AF127	35p	BF336	33p
ASZ17	120p	BFX30	32p
AU113	150p	BFX86	26p
BC107	7p	BFX88	22p
BC108	7p	BFY50	13p
BC108A	7p	BFY51	13p
BC108C	7p	BFY64	28p
BC136	15p	BFY90	56p
BC140	28p	BSX19	80p
BC141	30p	BSY95A	16p
BC142	25p	BU204	149p
BC143	28p	BU208	150p
BC147	6p	OC29	89p
BC147B	6p	OC43	50p
BC149	7p	2N696	15p
BC149C	7p	2N930	20p
BC159	9p	2N1132	19p
BC160	35p	2N1304	40p
BC167A	10p	2N1613	12p
BC178	12p	2N1711	15p
BC179	12p	2N2217	20p
BC182	8p	2N2219A	20p
BC182L	9p	2N2221	18p
BC183	9p	2N2368	15p
BC183L	9p	2N2369	14p
BC184L	9p	2N2894A	20p
BC186	20p	2N2904	15p
BC212	9p	2N2904A	15p
BC212L	9p	2N2905	15p
BC213B	9p	2N2906	15p
BC327	13p	2N2926Y	10p
BC328	13p	2N2926O	10p
BC337	16p	2N2926R	10p
BC338	11p	2N3442	102p
BC440	32p	2N3702	8p
BC547	9p	2N3704	8p
BC548	9p	2N3705	8p
BC550	14p	2N3708	8p
BC558	12p	2N3709K	8p
BCY33	99p	2N3866	35p
BCY34	99p	2N3906	10p
BCY39	229p	2N4058	12p
BCY58	16p	2N4427	60p
BCY70	12p	Add VAT	

DIODES

AA119	10p
BA154	9p
BA156	9p
IN4001	4p
IN4002	4p
IN4003	5p
IN4005	5p
IN4006	6p
IN4007	6p
IN4148	5p
IS44	3p

OPTO

Leds	
125 Red	8p
125 Green	12p
125 Yellow	12p
2 Red	10p
2 Green	10p
Displays	
704	110p
741	160p
747	160p
750	160p

TRIACS

4A 400V	54p
4A 600V	60p
6A 400V	60p
6A 600V	66p
8A 400V	66p
8A 600V	72p
10A 400V	72p
10A 600V	84p
15A 400V	108p
15A 600V	126p
with internal trigger diac.	
4A 400V	66p
4A 600V	75p
6A 400V	75p
6A 600V	90p
8A 400V	90p
8A 600V	95p
10A 400V	95p
10A 600V	100p
15A 400V	120p
15A 600V	138p

Prices correct at time of going to press.

REGULATORS

7805	80p
7812	80p
7815	80p
7824	80p
7905	105p
7912	105p
7915	105p
7918	105p
7924	105p
LM309K	105p
LM320T5	105p
LM320T12	105p
LM320T15	105p
LM320T18	105p
LM323K	450p
LM340T5	80p
LM340T12	80p
LM340T15	80p
LM340T18	80p

TTL

7400	9p
7401	9p
7402	9p
7403	9p
7404	10p
7405	14p
7406	30p
7407	30p
7408	17p
7409	17p
7410	12p
7412	17p
7413	25p
7414	45p
7416	25p
7417	25p
7420	14p
7427	28p
7430	14p
7432	22p
7438	26p
7442	48p
7447	50p
7450	15p
7451	15p
7470	30p
7472	25p
7474	20p
7475	27p
7480	40p
7482	60p
7486	25p
7491	63p
7492	35p
7493	28p
7494	63p
7495	63p
74100	110p
74107	30p
74121	25p
74122	36p
74123	44p
74145	72p
74154	80p
74157	60p
74161	85p
74175	63p
74180	84p
74181	151p
74191	80p
74192	80p
74193	80p
74194	80p
74LS00	11p
74LS01	11p
74LS02	12p
74LS03	12p
74LS04	12p
74LS10	19p
74LS11	20p
74LS20	18p
74LS30	18p
74LS32	24p
74LS42	89p
74LS51	24p
74LS55	28p
74LS74	39p
74LS75	46p
74LS76	39p
74LS85	99p
74LS90	36p
74LS93	79p
74LS114	49p
74LS122	65p
74LS123	65p
74LS124	115p
74LS132	89p
74LS139	79p
74LS151	89p
74LS155	91p
74LS156	89p
74LS157	69p
74LS165	69p
74LS168	139p
74LS174	99p
74LS175	99p
74LS190	110p
74LS192	115p
74LS194	115p
74LS195	115p
74LS196	95p
74LS197	125p
74LS257	99p
74LS260	99p
74LS273	199p
74LS367	59p
74LS378	159p

CMOS

4000	14p
4001	14p
4002	14p
4006	69p
4007	16p
4008	79p
4009	36p
4010	36p
4011	19p
4012	16p
4014	59p
4015	73p
4016	42p
4017	79p
4018	79p
4019	45p
4020	89p
4021	83p
4022	79p
4023	16p
4024	49p
4025	17p
4026	129p
4027	39p
4028	59p
4029	89p
4030	49p
4034	189p
4035	99p
4042	69p
4043	86p
4044	83p
4046	109p
4049	45p
4050	63p
4051	69p
4052	69p
4053	69p
4066	49p
4069	17p
4070	17p
4071	17p
4072	17p
4073	17p
4075	19p
4076	75p
4077	35p
4081	19p
4082	17p
4160	105p
4161	105p
4162	105p
4163	105p
4402	36p
4404	110p
4412	86p
4445	174p
4446	148p
4502	99p
4511	89p
4512	89p
4514	229p
4515	229p
4516	99p
4520	70p
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4556	69p
4581	269p
4582	115p
4584	59p
4585	99p

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(already modified)

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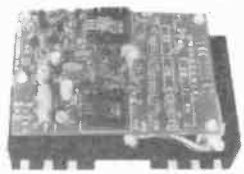

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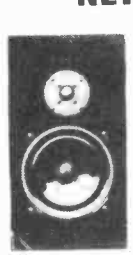

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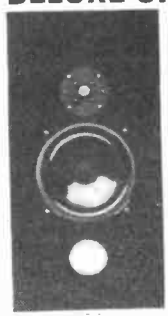

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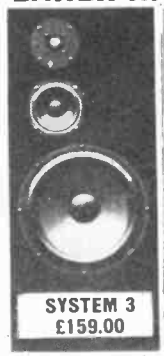

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DESIGNER'S NOTEBOOK

In this month's 'Notebook' Ray Marston explores the mysterious depths of 'zero-voltage switching' of mains power and looks at some practical applications of the CA3059 'zero-voltage' IC.

There are two basic ways of switching mains power to a load — either via a mechanical switch or via a solid state switch such as a triac. Mechanical switches are fairly slow acting devices: they suffer from severe arcing at the moment of switching and generate a great deal of RFI (radio-frequency interference) at switch-on and switch-off. This RFI can often be heard on domestic radio and TV sets and can cause malfunctioning of delicate electronic equipment.

Triac switches are fast acting devices and do not suffer from arcing problems. Nevertheless, they are still capable of generating considerable RFI at switch on. Why? As the triac turns on, the load current may rise from zero to several amps in a mere couple of microseconds: since this current flows through the mains wiring, the wiring may radiate a great 'splurge' of RFI in response to this heavy surge current. The magnitude of the RFI is proportional to dI/dt and can be reduced by either reducing the surge current amplitude or increasing the surge current rise time, or possibly both: once the triac has turned on, the subsequent large 'rise time' of the 50 Hz mains signal causes virtually zero RFI even when load currents of tens of amps are being drawn.

Zero-Voltage Switching

Thus, the degree of triac switch-on RFI is proportional to the value of instantaneous mains voltage at the moment of triac turn-on. If a 100R load is being driven from 230 V AC mains, the surge current will be 3A25 if switch-on occurs at a 'crest' value of 325 V, or mere 32.5 mA if switch-on occurs at a 'near zero-crossover' value of 3V25.

Triacs are self-latching devices. If they are turned on by a brief gate signal, they remain on until their main-terminal currents fall below a minimum 'holding' value

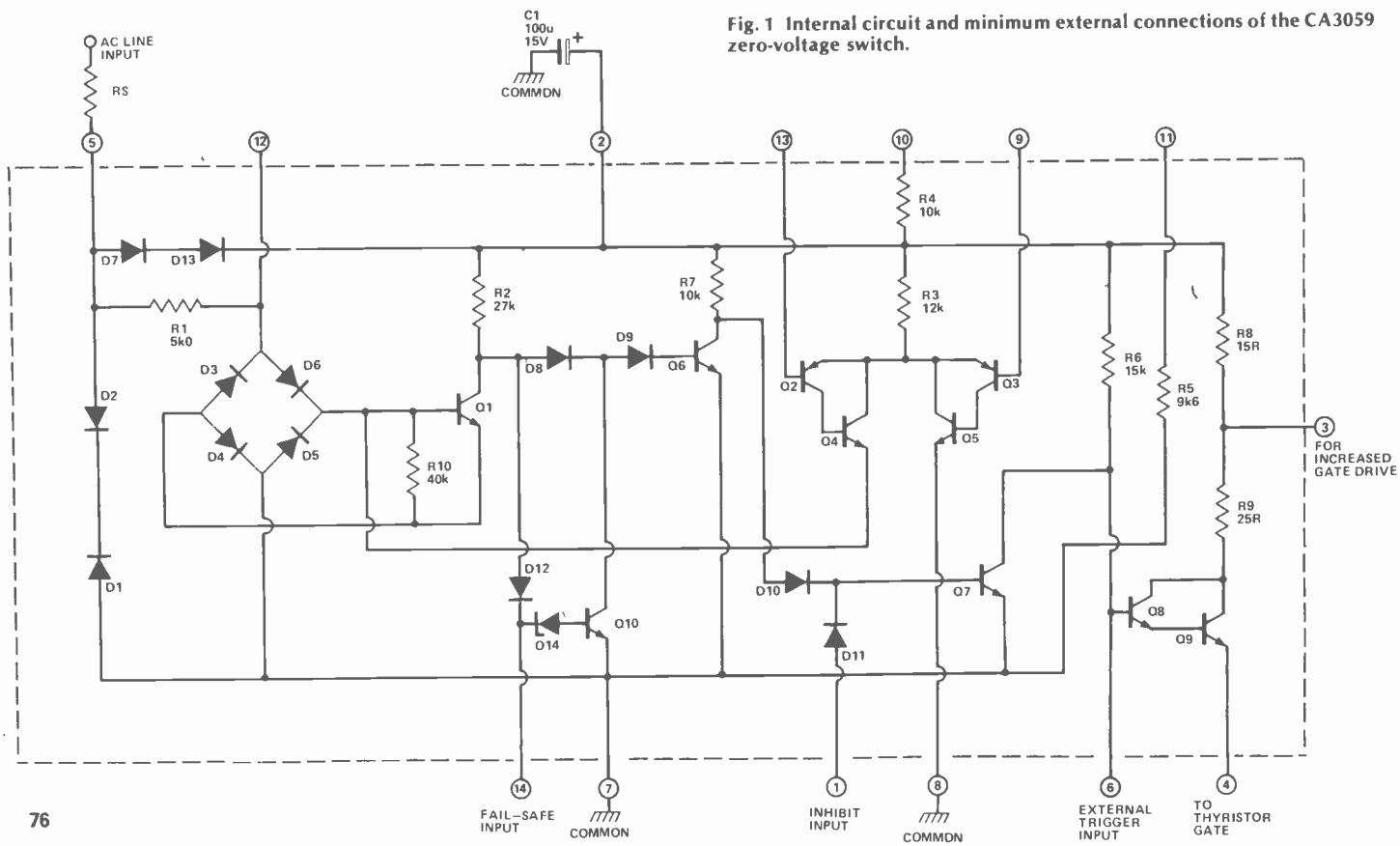

Fig. 1 Internal circuit and minimum external connections of the CA3059 zero-voltage switch.

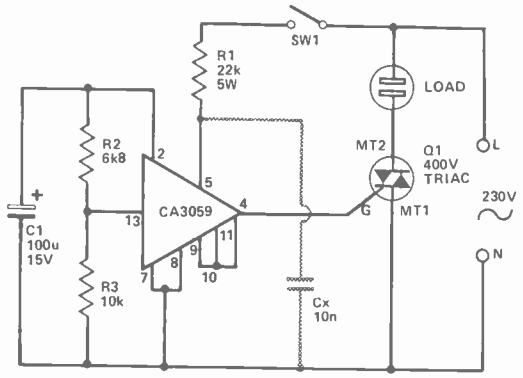

Fig.2 A simple mains-switched zero-voltage switch. Cx may be used to overcome latching deficiencies of some triacs.

of a few milliamps. They automatically turn off at the end of each mains half cycle as their main-terminal currents fall to near-zero. They can be turned on near the start of each half cycle as soon as their main-terminal currents are capable of exceeding the minimum holding value.

Thus, a triac can be persuaded to generate virtually zero switch-on RFI by feeding it with gate current *only* when the instantaneous mains voltage is close to the zero or cross-over value at the start of each half cycle. This technique is known as 'zero-voltage switching'. Special zero-voltage triac-driving ICs are available from a number of manufacturers. One such device is the CA3059, manufactured by RCA.

The CA3059 Zero-Voltage Switch

The internal circuit and minimal external connections of the CA3059 zero-voltage switching IC are shown in Fig.1. The device is housed in a 14-pin DIL package and incorporated DC power supply circuitry, a zero-crossing detector, triac gate drive circuitry and a high-gain differential amplifier/gating network. Circuit operation is as follows.

Mains power is connected between pins 5 and 7 of the device via limiting resistor Rs (22k, 5 W when 230 V mains is used). D1 and D2 act as back-to-back zeners and limit the pin 5 voltage to ±8 V. On positive half cycles D7 and D13 rectify this pin 5 voltage and generate approximately 6V5 across the 100uF capacitor connected to pin 2. This capacitor supplies sufficient energy storage to drive all internal circuitry and provide adequate triac gate drive, with a few milliamps or so spare drive available for powering auxiliary (external) circuits.

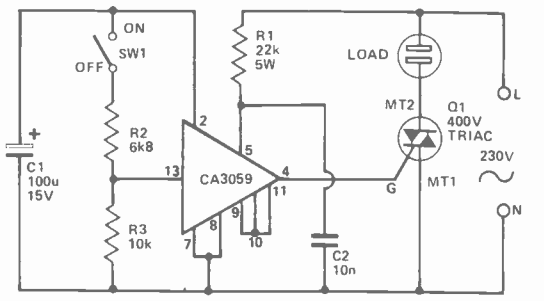

Fig.3 Direct-switched zero-voltage switch.

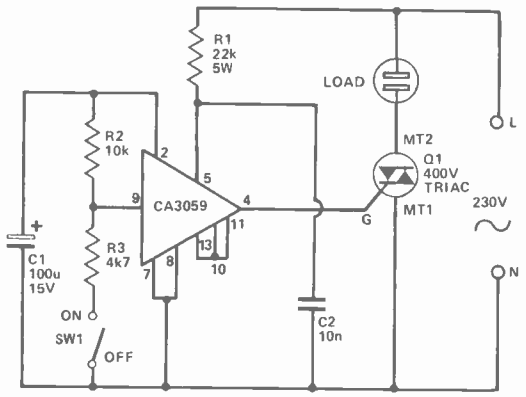

Fig.4 An alternative and very useful method of direct-switching the CA3059 IC.

Bridge rectifier D3-D6 and transistor Q1 act as a zero-voltage detector, their action being such that Q1 is turned on (driven to saturation) whenever the pin 5 voltage exceeds ±3 V. Gate drive to an external triac can be made via the emitter (pin 4) of the Q8-Q9 Darlington pair of transistors, but is available only when Q7 is turned off. When Q1 is turned on (pin 5 greater than ±3 V) Q6 is turned off through lack of base drive, so Q7 is driven to saturation via R7 and no triac gate drive is available from pin 4. Triac gate drive is thus available only when pin 5 is close to the 'zero-voltage' or cross-over mains value. When gate drive is available, it is delivered in the form of a narrow pulse centred on the cross-over point with pulse power supplied by C1.

Vive La Differential

The CA3059 incorporates a differential amplifier or voltage comparator, built around Q2 to Q5, for general purpose use. Resistors R4 and R5 are externally available for biasing one side to the amplifier. The emitter current of Q4 flows via the base of Q1 and can be used to disable the thyristor (pin 4) gate drive by turning Q1 on. The configuration is such that the gate drive can be disabled by making pin 9 positive relative to pin 13. The drive can also be disabled by connecting external signals to pin 1 and/or pin 14.

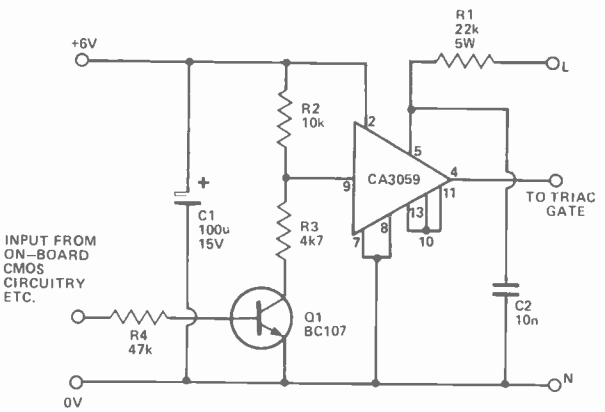

Fig.5 One method of transistor-switching the CA3059 via on-board CMOS circuitry such as one-shots, astables, etc.

CA3059 Switching circuits

Figure 2 shows the simplest possible way of using the CA3059 as a 'noiseless' switch with the zero-voltage switching provided via the IC and the triac and with on/off switching controlled by SW1. The circuit action is quite simple. The IC is connected to the mains via SW1 and limiting resistor R1. DC energy is stored by C1. The IC is wired in the 'enabled' mode by biasing the pin 9 side of the internal differential amplifier at half-supply (DC) volts via the pin 10 and 11 connections and by biasing the pin 13 side above half-supply via the R2-R3 divider network. Switch SW1 passes only a few milliamps of current and thus generates negligible RFI. The circuit can power mains loads such as lamps and heaters via a suitable rated triac.

The 'zero-voltage' triac-gate-drive pulse of the CA3059 is very narrow. In some applications, the pulse may terminate before the triac main-terminal currents have reached their minimum holding levels and self-latching may fail to occur. This problem can be overcome by wiring Cx as shown in Fig. 2. This capacitor, in conjunction with R1, gives a slight phase shift to the pin 5 signal and extends the 'zero-voltage' pulse further into the start of each mains half-cycle. A value of 10nF is adequate in most applications.

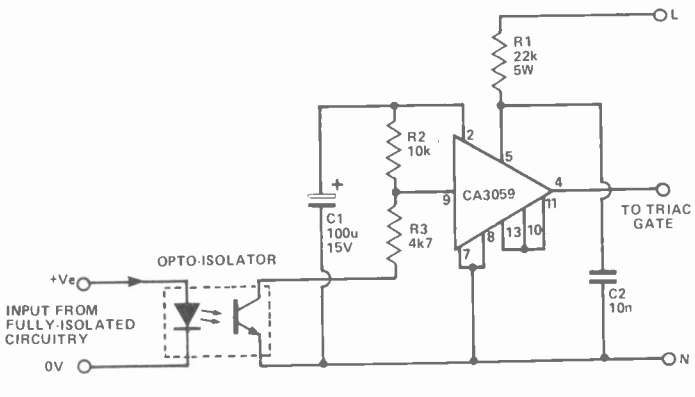

Fig.6 A method of remote-switching the CA3059 via an opto-isolator.

The Fig. 2 circuit consumes virtually zero mains power under the 'off' (SW1 open) condition. The only defect of the circuit is that SW1 operates at full mains voltage. This defect can be overcome by using the switch to directly enable or disable the CA3059 logic circuitry, as shown in Figs. 3 and 4, but in this case the circuit consumes a few watts of power (via R1) when the circuit is in the off mode.

The Figs. 3 and 4 circuits work by using the switch to enable or disable the triac gate drive via the internal differential amplifier of the IC. Remember, the drive is enabled only when pin 13 is biased above pin 9. In the Fig. 3 circuit, pin 9 is biased at half-supply volts and pin 13 is biased via R2-R3 and SW1. In Fig. 4, pin 13 is biased at half-supply and pin 9 is biased via R2-R3 and SW1. In both circuits, SW1 handles maximum potentials of 6 V and maximum currents of 1 mA or so.

Note in Fig. 4 that the circuit can be turned on by pulling R3 low or can be turned off by letting R3 float. Figures 5 and 6 show how this simple fact can be put to use to extend the versatility of the circuit. In Fig. 5, the circuit can be turned on and off by transistor Q1, which

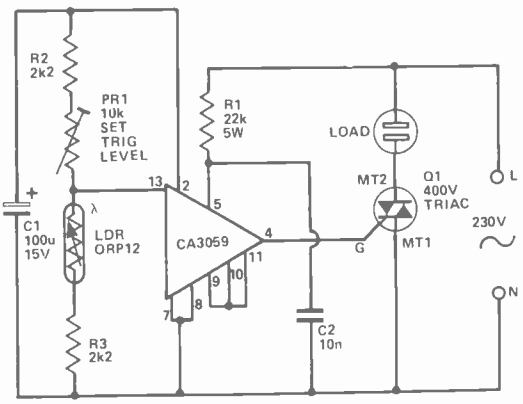

Fig.7 A basic dark-activated zero-voltage switch.

in turn can be activated by on-board CMOS circuitry (such as one-shots, astables, etc) that are powered from the 6 V pin 2 supply.

In Fig. 6, the circuit can be turned on and off by fully-isolated external circuitry via an inexpensive opto-isolator: the isolator needs an input current of only a milliamp or so to give the 'on' action.

CA3059 Comparator Circuits

The built-in differential amplifier of the CA3059 can readily be used as a precision voltage comparator that turns the triac on or off when one of the comparator input voltages goes above or below the other. If these input voltages are derived from transducers such as LDRs or thermistors, the on/off power control action can be controlled by ambient light levels or temperatures. Figures 7 to 10 show some practical circuits of these types.

Figure 7 shows the circuit of a simple dark-activated zero-voltage power switch. Here, pin 9 is tied to half-supply volts and pin 13 is controlled via the R2-PR1-LDR-R3 potential divider. Under bright conditions the LDR has a low resistance, so pin 13 is above pin 9, the triac is enabled and power is fed to the load. The precise threshold level of the circuit can be preset by PR1.

Figure 8 shows how a degree of hysteresis or 'backlash' can be added to the above circuit, so that the triac does not switch annoyingly in response to small changes (passing shadows, etc) in the ambient light level. The hysteresis level is controlled via R3, which can be selected to suit particular applications.

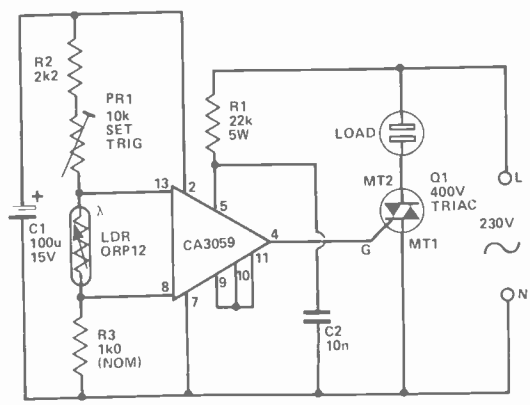

Fig.8 A dark-activated zero-voltage switch with hysteresis provided by R3.

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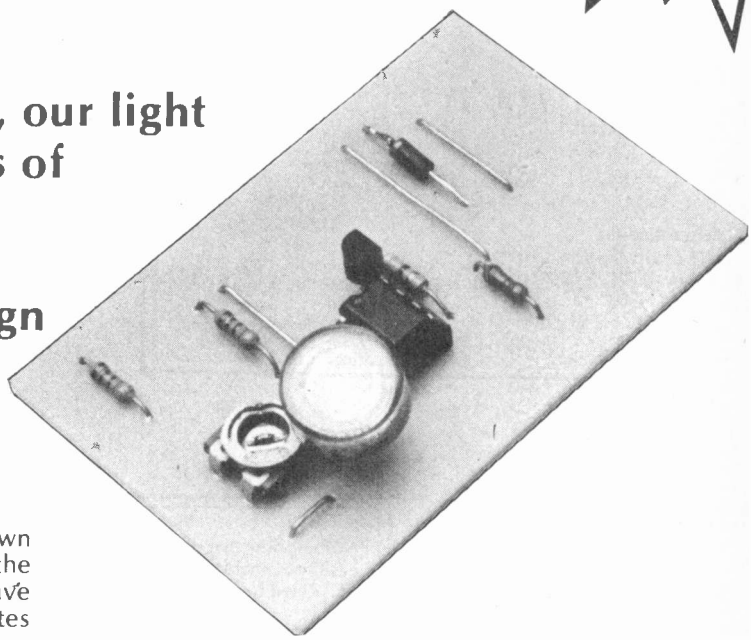


Got a light switch? No, but I've got a dark brown multiplexer. Seriously though, this project using the ETI multi-option board is a must if you have need of a sensitive light operated switch which operates (turning either on or off) when the light exceeds a predetermined level. Such a device can be the heart of an automatic porch light, which turns on at dusk as the ambient light level falls below a certain amount. It could be used as part of a burglar alarm system — the switch operating when light from, say, a burglar's torch activates it.

The circuit diagram of the ETI Light Switch shows the device in its low-light operating mode. When the amount of light on the photocell, LDR1, is lower than the preset amount, the relay is energised. Alternatively, swapping LDR1 and R1 causes the relay to be energised when the light exceeds the preset level.

A single operational amplifier is the active component of the circuit and we have specified this as a type 301. However, don't rush out specially to buy one if you don't have one of these at hand, the only reason we used this particular type was because we had one handy at the design stage. Virtually any 8-pin DIL op amp will function in the circuit eg. 741, 748, 308, 3130, 351, etc can be used as substitutes.

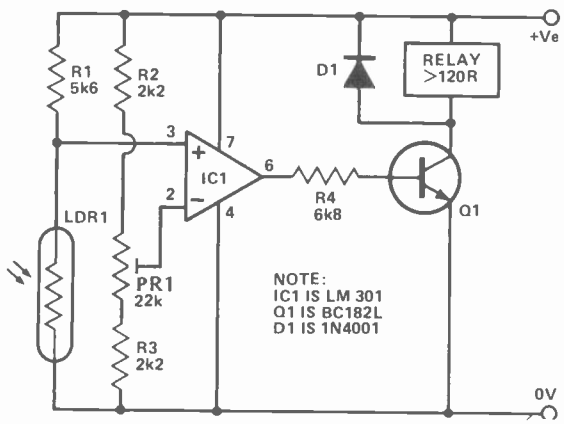


Fig.1. Circuit diagram. The switching threshold is controlled by PR1.

Construction

Construction, to use a well-worn phrase, is easy if you follow our PCB layout. It is easier still if you have the Multi-Option Board given free with this issue.

There are four links to make and these are best inserted before the components. Next, insert the resistors, the preset pot and the diode. Transistor Q1 is inserted next to IC1, using three of the remaining holes included in the board for a 14 pin DIL IC. Make sure you insert Q1 and the IC the right way round. Finally, make all the off-board connections to the battery, relay and photocell and then switch on and try your completed project. The light level at which the switching action occurs can by adjusted by PR1.

HOW IT WORKS

LDR1 is a light dependent resistor. The resistance between its terminals varies in inverse proportion to the amount of light which falls on its face — the greater the light intensity the less its resistance. So when it is connected across a power supply with another resistor in series, (R1 in this circuit), the *voltage* across it decreases with light intensity.

IC1 is a comparator which compares the voltage across the LDR with a predetermined voltage, obtained via resistor chain R2,3 and PR1. As the light level falls, the voltage across the LDR rises until it exceeds the preset level at PR1. At this point the output of IC1 goes high, turning on Q1, which in turn, operates the relay. D1 prevents damage to Q1 from any back EMF when the relay is switched off.

Swapping the positions of LDR1 and R1 means that the voltage at pin 3 of the comparator now rises with *increasing* light, so circuit operation is reversed.

PARTS LIST

Resistors All ¼W 5%	
R1	5k6
R2,3	2k2
R4	6k8
Potentiometer	
PR1	22k miniature horizontal
Semiconductors	
IC1	LM301
Q1	BC182L
D1	1N4001

Miscellaneous
ETI Multi-Option Board
Relay (coil 120R)
LDR1 ORP 12
9 V battery and connector.

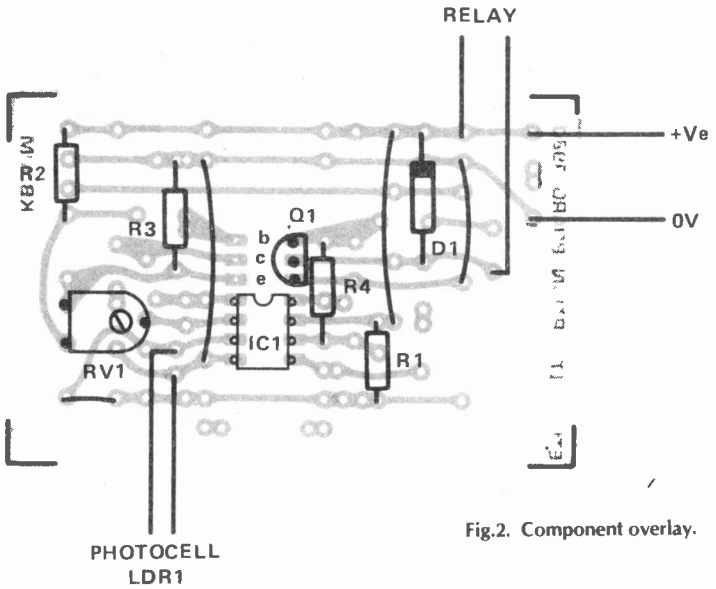


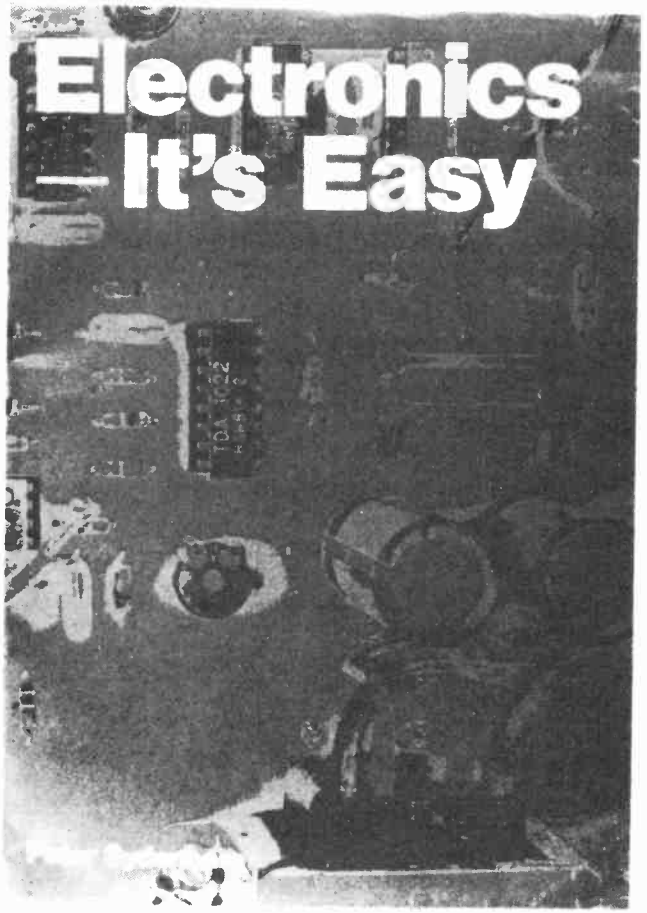
Fig.2. Component overlay.

BUYLINES

Nothing here that should cause any problems, all of the components are easily obtainable items. Make sure you get a BC182L; the pin-out for the BC182 is different.

ETI

WOULD WE LIE TO YOU?



No, we wouldn't. Electronics *is* easy – unless you're trying to learn about it from some dry-as-dust textbook containing page after page of equations. What is needed is a comprehensive and simply-written guide which explains the theory – and the practice – of electronics step by step. So we've provided such a guide, by collecting together our popular series Electronics – It's Easy. Originally published in three parts, the demand was so great that we have reprinted it as a single volume.

Electronics – It's Easy looks clearly and logically at the whole of this far-ranging subject, starting with the basic concepts and working through to the how and why of today's technology. You can obtain your copy by sending a cheque or postal order (payable to Modmags Ltd) for £3.60 plus 80p postage and packing to: Sales Office (Specials), Modmags Ltd., 145 Charing Cross Road, London WC2H 0EE. Please write your name and address on the back of your remittance.

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Max. Output power	125 watt RMS
Operating voltage (OC)	50-80 Max.
Loads	4-16 ohms
Frequency response Measured at 100 watts	25Hz-20kHz
Sensitivity for 100 watts	400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load	0.1 %
Dimensions	205 x 90 and 190 x 36 mm

The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, the output stage uses four 115 watt transistors normally only two would be used, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chassis is preformed and ready to use, supplied with all parts and circuit diagrams.

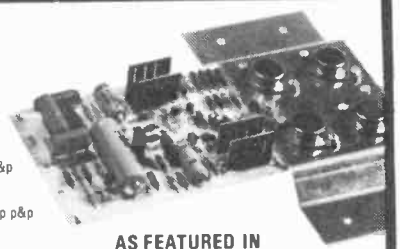
125 watt power amp kit **£9.50** plus £1.00 p&p

ACCESSORIES

Suitable L.S. coupling electrolytic **£1.00** plus 20p p&p

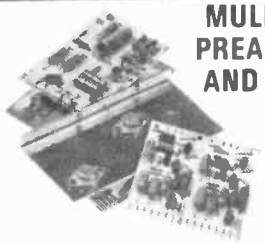
Suitable Mains Power Supply Unit sufficient for one power amp **£7.50** plus £2.75 p&p

ACCESSORIES available only when purchasing packs.



AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES



MULLARD STEREO PREAMP MODULES AND TWO 12 WATT POWER AMP KITS.

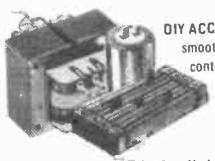
In easy to build form P.C.B.s backprinted, etched and drilled ready to use.

BUILD A 12 WATTS PER CHANNEL STEREO AMPLIFIER ACCESSORIES AND L.S. KIT EXTRA *(not available separately)* **£6.00**

DIY PACK 1 2 x power amp kits LP1182/ preamp module, suitable for ceramic and auxiliary inputs. **£6.00** plus £1.10 p&p

DIY PACK 2 2 x power amp kits LP1184 preamp module suitable for magnetic ceramic and auxiliary inputs. **£8.50** plus £1.15 p&p

DIY SPEAKER KIT Two 8" x 5" approx. 4 ohm bass. **£3.50** plus £1.70 p&p



DIY ACCESSORIES Mains transformer smoothing capacitor rectifier 4 x slider controls, for base, treble and volume. **£3.00** plus £1.60 p&p

ACCESSORIES: Available only at time of purchase of Bargain Packs

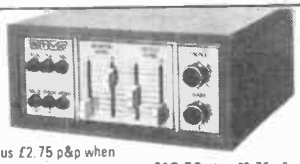
12 + 12 WATT AMPLIFIER KIT

NOTE: for use with 4 to 8 ohms speakers

With up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.
Size 9¼" x 8¾" x 4" approx.

NOTE:
for use with 4 to 8 ohms speakers.

£13.95 plus £2.55 p&p



BSR chassis record player deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £2.75 p&p when purchased with amplifier available separately **£10.50** plus £2.75 p&p.

TWO WAY SPEAKER KIT. 2 Phillips 8" approx speakers **£4.75** per stereo pair plus £1.50 p&p when purchased with amplifier available separately **£6.75** plus £1.50 p&p.

ALSO AVAILABLE Stereo magnetic pre-amp conversion kit all components including P.C.B. to convert your ceramic input on the 12 + 12 amp to magnetic. **£2.00** when purchased with kit featured above. **£4.00** separately inc. p&p.

BSR Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.

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Size approx 15¼" x 12¼"

Hi Fi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge—*LIMITED STOCK.*

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MW and LW

- **Easy to build**
- **5 push button tuning**
- **Modern styling design**
- **All new unused components**
- **6 watt output**
- **Ready etched & punched P.C.B.**
- **Incorporates suppression circuits**
- **Now with tape input socket**

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.
Complete with instructions.

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Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit **£15.20** including p&p.
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Hobby Electronics

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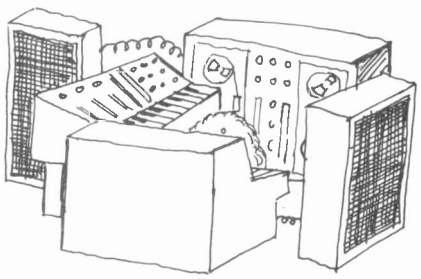
Next Month



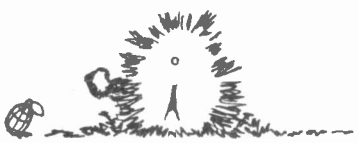
Thirty Pound Synthesiser

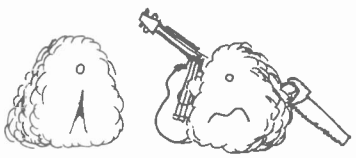
No, not weight, price! That's right, for around thirty quid you can build yourself this high quality, versatile and above all, economical synthesiser. Create outlandish noises, scare your granny, even play a few tunes. This easy-to-build unit features the latest LSI technology to reliably generate the sounds.

We're keeping quiet about the technical details, walls have ears and all that. Suffice it to say that this is the design you've been waiting for. You have four weeks, starting from now to find your £30. It'll be money well spent, we promise you that.

Electronic Hand Grenade

You'll get a real 'bang' out of this new game. It's the electronic version of that old parlour game 'musical chairs'. The grenade is passed around a circle of players, the longer it is held the greater the chance it will go 'off'. The person that has it then leaves. This ingenious little circuit will provide hours of amusement at parties and can be built by even the most inexperienced constructor in just a couple of hours.





Guitar Sound Shaper

Gasp, shock, horror, you haven't heard of a Guitar Sound Shaper before. Shame on you. How can you ever hold your head up in decent company? People like you give our hobby a bad name, no wonder dogs cross the street when they see you. There's only one thing you can do, rush out and get next month's copy of HE or forever be a social outcast.

Battery Eliminator

This 35 kilowatt laser is guaranteed to instantly vapourise any battery from a HP7 to a PP9. Batteries are really becoming a nuisance. Stop their takeover right now. The HE battery Eliminator will forever remove the menace of the dry-cell. Just plug it into your local mains socket and laugh as you count all the money you'll save. Actually it's not really a 35 kilowatt laser but it will save you a few quid. Look out for it in next month's bigger-than-ever issue.

Transistor Tester

What can we say? Not a lot really, we don't have to tell you that this is the most advanced design ever to measure the collector current of a BC109, you know that already because it comes from Hobby Electronics!

Stereo

Now for the first time anywhere this century Hobby Electronics has commissioned that Master of the Microcircuit, the Baron of the Breadboard, that well known man of digits, Ian Sinclair (who?) to write the definitive lowdown on Stereo. What is it, how does it do it, what do I do with it? These are just some of the questions that will finally get answered next month in this exciting top-level feature.

The items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

RADIOACTIVITY

Spend the last three minutes before the bomb drops reading A.S. Lipson's excursion into that frazzling phenomenon of modern physics — radioactivity

In the last few years of the nineteenth century, a French scientist by the name of Henri Becquerel was fiddling about with some uranium compounds, trying to investigate their fluorescent properties. During the course of his work, however, and almost completely by chance, he discovered something quite different. These compounds could fog photographic plates, even if the plates were wrapped in black paper to keep out light! Henri Becquerel had discovered radioactivity.

One Into Three

As more and more work was done on the new phenomenon, it was eventually found that there are three main types of radiation. These are known, respectively, as alpha, beta and gamma rays, after the first three letters of the Greek alphabet (scientists and mathematicians long ago ran out of English letters to use as symbols. In fact, they're running short of Greek now, as well. Hebrew letters — Oy Vey! — are beginning to come into use for some things).

What makes the three types of radiation different from each other, though? Suppose we have a lump of some radioactive material. We know it's giving off rays of some sort, but how do we find out which type they are?

Eeny Meeny. . . .

Well, actually it isn't all that bad. The three radiation types have quite different properties from each other and it's quite easy to tell the difference between them. One of the simplest ways is based on their different penetrating powers. Alpha rays; you see, don't take an awful lot of stopping. Even a moderately thick piece of paper in the way is enough to cut out most of them. Beta and gamma radiation, however, are not stopped so easily. It takes several millimetres of aluminium or lead to block off beta radiation effectively and as for gamma — nothing short of several centimetres of lead will stop that.

Shields Up, Scotty

Suppose, then, that we have a radioactive source and some means of detecting radiation, such as a Geiger counter (Fig.1). If we find that the radiation from the source is cut off when a piece of card is placed in front of the detector, then it is very likely that the radiation is alpha type. If the radiation is virtually unaffected by card, but is effectively stopped by 5 mm or so of lead, then it is probably beta radiation, whereas if it is only reduced by placing several centimetres of lead in the way, it is most likely to be gamma radiation.

Some radioactive materials give off more than one type of radiation, but, by finding the amount by which the radiation is reduced with different thicknesses of shielding, the amounts of each type present can be discovered. (Easy, Innit?).

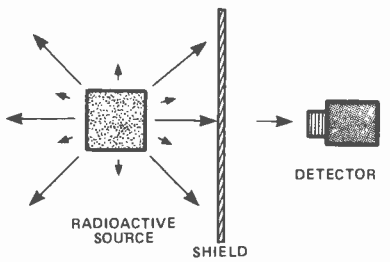


Fig.1. Alpha particles are stopped by thick paper. Beta particles are stopped by several millimetres of aluminium or lead. Gamma rays can only be stopped by several centimetres of lead.

There are other ways of detecting the difference between the three types of radiation. For instance, in an electric or magnetic field, alpha particles will be deflected one way and beta particles the other way, while gamma radiation remains unaffected. This is because alpha radiation carries positive electric charge, beta radiation carries negative charge and gamma radiation is neutral. By finding which way the radiation is bent in an electric or magnetic field, then, it is possible to work out what type of radiation it is (Fig.2). It is this method of detection, in fact, which is used by physicists to detect many other less common types of radiation and subatomic particles encountered in nuclear physics.

But What Are They?

So far, we have only looked at the different ways in which alpha, beta and gamma radiation behave without really saying much about what they are. What is it that makes a beta ray different from an alpha or a gamma ray? Why should alpha and beta radiation carry electrical charge — alpha positive and beta negative — while gamma radiation is neutral?

The Gamma Story

Light can be thought of as a wave of electromagnetic radiation travelling through space with a speed of nearly 300,000 kilometres per second with a wavelength of between 4×10^{-7} and 7×10^{-7} metres. In fact, the wavelength determines the colour of the light. There is, however, other electromagnetic radiation, travelling with exactly the same velocity as light and identical to it in every way except that of wavelength. Radio waves, for instance, are this type of radiation, but with much longer wavelengths (up to thousands of metres). Gamma radiation is also this sort of electromagnetic radiation, but with a much *shorter* wavelength than light (anything under 10^{-16} or 10^{-17} metres).

Gamma radiation, then, is very short wavelength electromagnetic radiation and as such it carries no electric charge, any more than light or radio waves do (Fig.3).

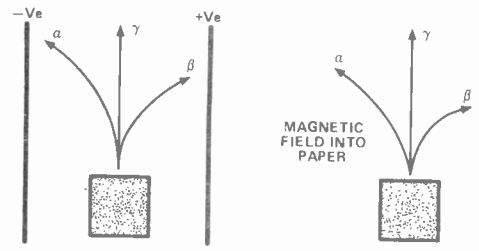


Fig.2. Alpha or beta particles carrying electrical charge can be deflected by electric or magnetic fields. Gamma rays, which are neutral, are not deflected.

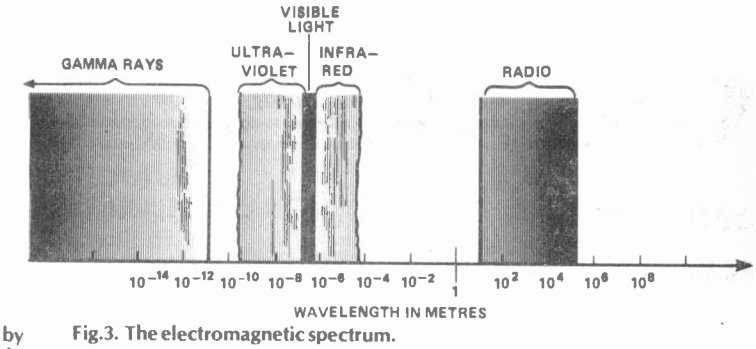


Fig.3. The electromagnetic spectrum.

A,B,. . .

Alpha and beta radiation are a little harder to explain. The atom consists of a very small, central region — the nucleus — which carries a positive charge. Surrounding the nucleus, and taking up the bulk of the atom, are electrons, which, being negatively charged, counteract the positive charge of the nucleus and make the atom as a whole neutral. The nucleus consists of two types of particles — protons and neutrons. Protons are positively charged and neutrons, as the name indicates, are neutral. The number of protons in the nucleus decides which element the atom belongs to. The number of neutrons present doesn't matter so much, but in most atoms there are at least as many neutrons as protons. (One notable exception is hydrogen, which has a nucleus consisting of just one proton). The protons, you see, being positively charged, all repel one another. The neutrons, by some mechanism still not properly understood, seem to hold the whole kaboodle together in a relatively stable lump. In some atoms, however, — particularly the larger ones, with more than 90 or so protons — the nuclei are not quite stable enough. In fact, they are liable literally to fall apart! This, as you probably guessed, is where the alpha and beta radiation comes in . . .

Let There Be Helium

It turns out that there are two ways in particular in which atoms 'like' to fall apart. One of them is by giving off two protons and two neutrons together, in a lump. In fact, this 'lump' is exactly the same as a normal helium nucleus, carrying the positive charge of two protons. It is this positively charged helium nucleus, which unstable atoms tend to release, that we call the alpha particle.

And what of the beta particle? Well, it was found by experiment that beta particles are actually free electrons. Because of this, you might be tempted to think that it was one of the electrons from around the atom, which has been released. This is not, however, the case. (It's such an obvious explanation that it can't possibly be right — Murphy's Law). Occasionally, within the nucleus, a neutron will turn into a proton, giving off an electron — and, at the same time, another particle called an anti-neutrino. The anti-neutrino really belongs in an article by itself, so we'll pass it by, except to say that it has no charge, little or no mass, and is virtually impossible to detect, although it is undoubtedly one of the most intriguing particles discovered yet. The electron given off when this happens is (you guessed it!) the beta particle.

We can see, then, that, although we say alpha, beta and gamma 'rays', only the gamma type is a ray. The other two types are really particles. However, when they occur in streams with large numbers of the particles, it is just as convenient to call them rays.

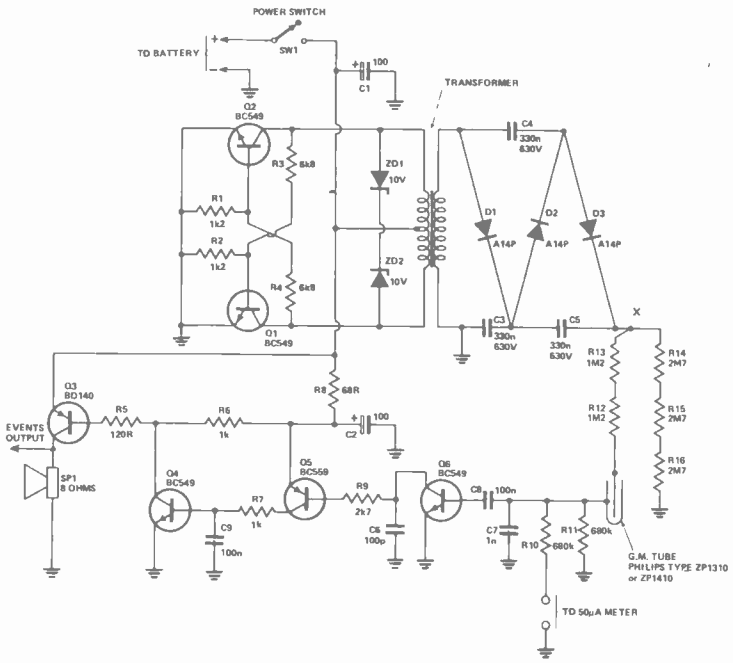


Fig.4. Circuit diagram of a Geiger-Muller tube radiation detector.

Lead Into Gold

A while back, we stated that the number of protons in the nucleus determined which element the atom belongs to. However, when alpha or beta radiation is given off, the number of protons changes (with alpha radiation, it decreases by two, and with beta radiation, it increases by one). Hence, when atoms 'decay' radioactively, by giving off alpha or beta radiation, they actually turn into other elements! Interestingly enough, the particular elements they turn into, when possessing the numbers of neutrons actually available, are not always themselves stable and so they may decay further. For instance, if you take an atom of astatine with 85 protons and 132 neutrons in the nucleus and allow it to decay radioactively, then it would decay into a bismuth atom by giving off an alpha particle. Now, although a bismuth atom with the right number of neutrons (126) is stable, the bismuth atom produced from astatine has 130 neutrons. Because of this, it is unstable, and will itself decay (usually giving off a beta particle, but occasionally an alpha). It is possible, in fact, to find whole chains of elements, which decay radioactively into one another!

Age Before Theory

One of the most exciting applications of all this (yes, it isn't just theory; there actually is a use for it) is in radio-carbon dating, in which it is possible to tell the age of an object from measurements of the amount of radioactive carbon in it. That, however, is another story altogether . . . . .

ETI

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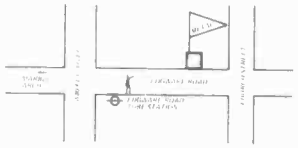
327 EDGWARE ROAD, LONDON, W2
01-723 4753

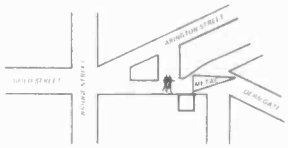


58 QUEENSWAY, LONDON, W2
Opposite Bayswater Tube Station
Shop open 12 hours/day, 7 days/week

Situated in the heart of London's fast-moving electronics area. A very large selection of watches and consumer electronics products. Also many bargain discount/sale items.

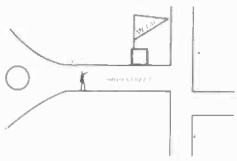
2nd only to Oxford Street, this is London's round-the-clock international tourist area. An excellent selection of expensive famous watches, plus all the popular models.

METAC IN NORTHAMPTON
11 ST. GILES SQUARE, NORTHAMPTON
Tel: (0604) 39550



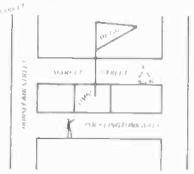
An excellent selection of watches and electronics. This shop also has televisions and video recorders to rent or buy.

METAC IN DAVENTRY
67 HIGH STREET, DAVENTRY



Situated in the middle of Daventry, only a short walk from Metac's Mail Order Centre, the shop stocks a wide range of watches and consumer electronic products. You may also rent or buy televisions and video recorders here.

METAC IN LEICESTER
OMNI SHOPPING CENTRE, 27 MARKET STREET
LEICESTER



Situated in the Omni walk-round shopping centre. Metac at Omni stocks an excellent range of quality watches at very attractive prices.

ALSO IN STOCK

NEW SEIKO	Digital-Analogue Alarm Chrono	£73
SEIKO	James Bond Memory Bank Now only	£39
BEL-TIME	Pico-Quartz 50 Function All Singing, all Dancing Wrist Computer	£29.95
BEL-TIME	Alarm	£12.95
BEL-TIME	Chronograph	£10.95
BULER	Swiss Digital and Quartz-Analogue Collection	
CASIO	Alarm Chrono. Lowest price anywhere. Send for details.	
OTRON	Korean Waterproof Ladies' and Gent's Solar Alarm Chronographs, etc.	
TRAFALGAR	Digital-Analogue Alarm Chronograph	£29.95

Also large selection of popular Dual-time, Alarm, Countdown, Musical, Ladies' and Gent's Watches.

WANT TO KNOW HOW THEY WORK?

Send £1 and we will send you the 40-page Watch Report. A technical survey which describes in detail the function and operation of electronic watches in a completely unbiased and objective way.

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For more information on Metac mail order products send for our free literature, brochure and watch-care leaflets, to:
METAC ELECTRONICS LITERATURE, 47 HIGH STREET, DAVENTRY, NORTHANTS.

POST COUPON TO: METAC (24 hour despatch centre), FREEPOST, 47a High Street, Daventry, Northants.

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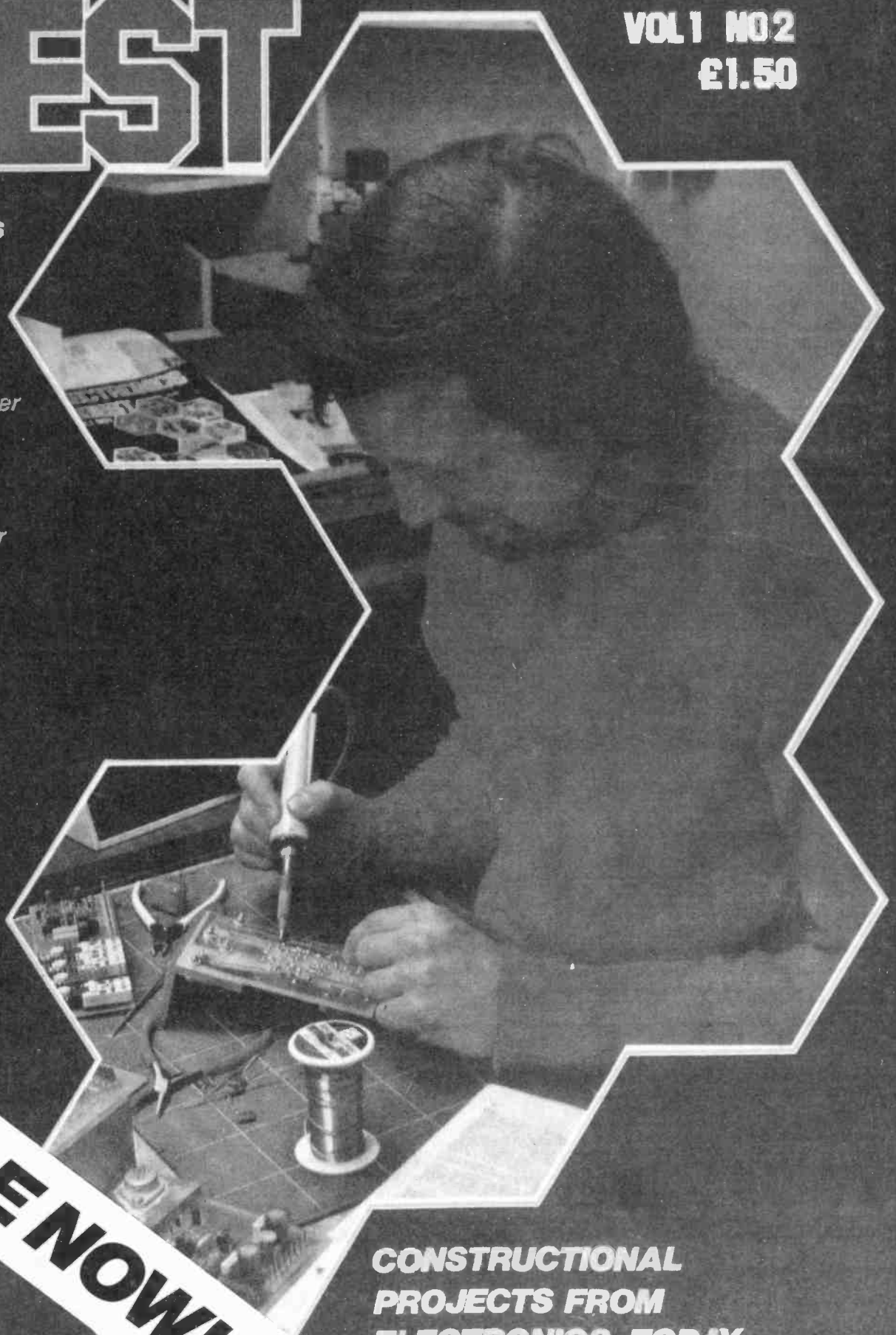

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- Click Eliminator
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DMM SURVEY

The DMM is an invaluable aid to both the handyman and the professional. Tina Boylan explores the low cost end of the digital multimeter market.

The seventies saw the emergence of the digital multimeter onto the test equipment market and since Fluke produced the 800A in 1972 an explosive growth in production and design has been witnessed. A short life-span (three to five years) and the continuing introduction of new models from America and the Far East, as well as from Great Britain, has ensured lower prices and improved performance. The original LED display has been forsaken for the LCD display, despite early teething problems like poor refractory angle, slow response and blackening after two or three years. The LCD display now boasts a life of ten years.

Analogue to Digital

The analogue meter has been with us for as long as 80 years and, despite its low cost, it contains some unwelcome characteristics which have caused problems in testing and for many of these problems the digital multimeter provides a more reliable service. Primarily the analogue meter contains moving parts which are prone to damage, overload, reverse polarity and wear. On the other hand the digital multimeter contains only electronic components, up to 20% of which may be used solely for protection purposes, and these, as well as being more rugged, mean that the meter itself can be made smaller and lighter than its analogue counterpart — by virtue of the latest integration methods.

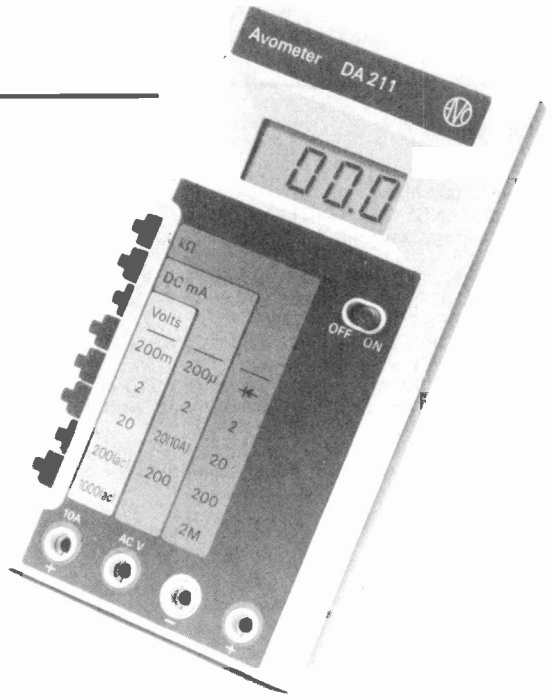
As far as hand-held DMMs are concerned, those with standard features, (voltage, current, resistance) are sure to continually drop in price, thus serving the end of the market traditionally held by the low cost hand-held analogue meter, while it maintains enough room to expand the capabilities of the same size meter for including complicated features.

For the professional, analogue meters can still appear to provide better testing facilities, particularly where bench-top models are concerned, but this is a myth which is fast being disproved by the technical advances being made in the DMM field. Until recently digital versions gave difficulty in reading transients or peaks because of the rapidly changing display, due in part to the fast analogue/digital conversion times of the DMM. The latest models now incorporate a peak reading memory, and these even take the guesswork out of watching a moving needle and making approximate readings.

Microprocessors

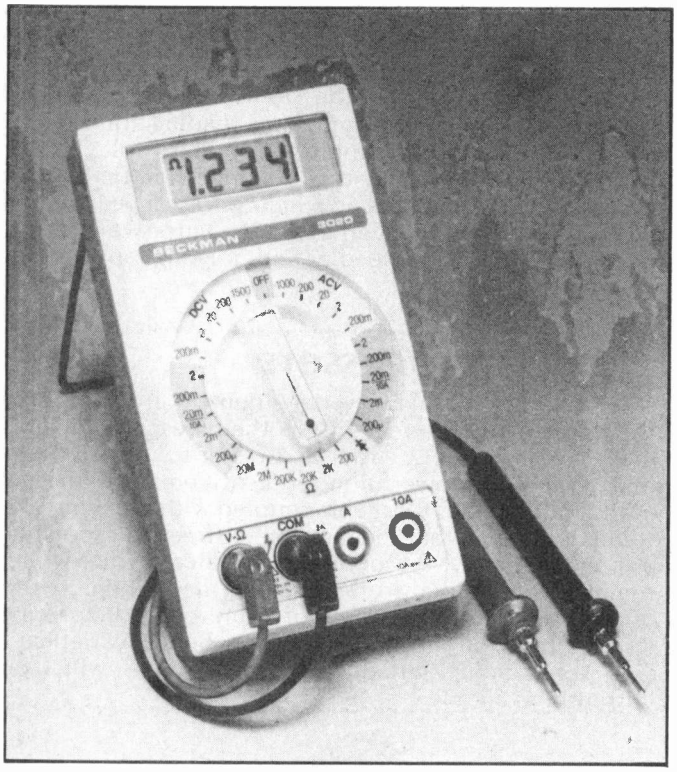
Present trends in DMM development are focusing on the use of microprocessors in their design which will make the instrument easier and faster to use, as well as making it more powerful in terms of computational and mathematical facilities. This coupled with lowering price trends will mean that the man in the street will soon have a sophisticated DMM for his handyman activities while it remains an essential to the engineer and technician.

ETI has compiled a list of some of the low priced DMMs, both of the hand-held and bench varieties, to give some indication of the diverse types which are currently available.

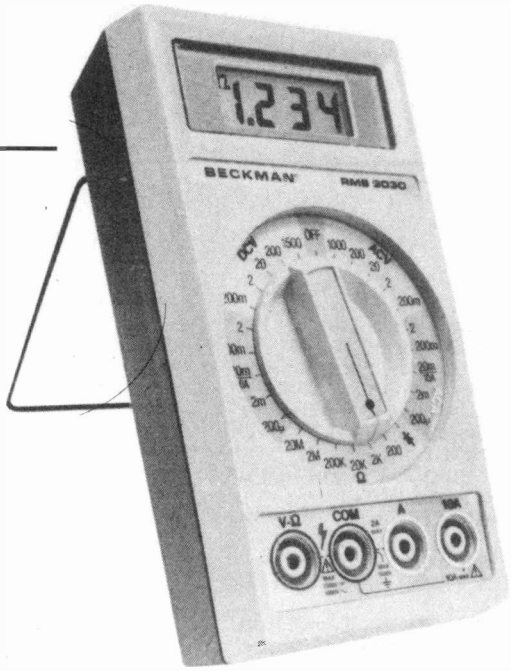


AVOMETER DA211
PRICE: £45.00 ex. VAT
BATTERY: Single 9 V dry cell
BATTERY LIFE: 200 hours approx.
DIMENSIONS: 90 x 171 x 31 cm
WEIGHT: 280 g
SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 V to 1000 V
DC AND AC CURRENT: 4 ranges, 200 uA to 200 mA plus 5th range measuring up to 10 A DC.
RESISTANCE RANGE: 4 ranges, 0 and 2M0 plus low voltage diode test facility.
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 13 mm
READING RATE: 2.5/S
OVERLOAD PROTECTION: 500 mA fuse
OTHER FEATURES: Auto-polarity, auto-zero.

AVOMETER DA212
PRICE: £65.00 ex VAT
BATTERY: Two R6 (HP7)
BATTERY LIFE: Approx. 200 hours
DIMENSIONS: 160 x 96 x 47 mm
WEIGHT: 340 g
SELECTION OF RANGE OR FUNCTION: Rotation of two selector switches.
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V
DC AND AC CURRENT: 200 uA to 1000 mA
RESISTANCE RANGE: Two voltage levels, Hi or Lo, by push button.
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 13 mm
READING RATE: 2.5/S
OVERLOAD PROTECTION: to 1000 V on voltage ranges and 250 V on all other functions.
OTHER FEATURES: Controlled by on/off switch, auto-polarity, auto-zero, battery low indicator.



BECKMAN 3020
PRICE: £115.00
BATTERY: 9 V transistor type
BATTERY LIFE: 2,000 hours
DIMENSIONS: 17.4 x 9.3 x 4.6 cm
WEIGHT: 453 g
SELECTION OF RANGE OR FUNCTION: Single central dial
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1500 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
DC AND AC CURRENT: 5 ranges, 200 uA to 2 A. Separate input extends this to 10 A.
RESISTANCE RANGE: 6 ranges from 200R to 2M0
DISPLAY: 3½ digit LCD
OVERLOAD PROTECTION: Voltage input protected to 1500 RMS AC. Resistance protected to 300V DC or RMS AC. Current inputs with 2 A fuse.
OTHER FEATURES: Insta-Ohms™ instant continuity test indicator, semiconductor test function provides 5 mA of test current, accuracy within 0.1% ± 1 digit on all DC voltage ranges, battery low indicator.



BECKMAN RMS 3030
PRICE: £176.00
BATTERY: 9 V transistor type
BATTERY LIFE: 2,000 hours
SELECTION OF RANGE OR FUNCTION: Rotary switch
FUNCTIONS: Voltage, current, resistance, AC voltage and current in true RMS.
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1500 V
AC VOLTAGE RANGE: 200 mV to 1000 V in true RMS
DC AND AC CURRENT: 200 uA to 2 A
RESISTANCE RANGE: 6 ranges from 200R to 2M0
DISPLAY: 3½ digit LCD
OVERLOAD PROTECTION: Input up to 1500 V DC or 1000 V RMS, resistance up to 300 V DC or RMS. Current inputs with 2 A fuse, 10 A range up to 20 A for 30 S.
OTHER FEATURES: Instant continuity test, RMS input accuracy is 0.5%, battery low indicator, calibration guaranteed for one year.

FLUKE 8022A
PRICE: £75.00
BATTERY: 9 V
BATTERY LIFE: Alkaline 200 hours, zinc-carbon 150 hours.
DIMENSIONS: 18.0 x 8.6 x 4.5 cm
WEIGHT: 37 g
SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.
FUNCTIONS: 6 functions, 24 ranges
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V
DC AND AC CURRENT: 4 ranges, 2 mA to 2000 mA
RESISTANCE RANGE: 200R to 20M
DISPLAY: 3½ digit LCD
OVERLOAD PROTECTION: Withstands 500 V on resistance, 1000 V on voltage, 2 A on current and 6 kV voltage transients.
OTHER FEATURES: Auto-polarity, auto-zero, battery low indicator, Tilt Stand.

FLUKE 8024A
PRICE: £135.00
BATTERY: 9 V
BATTERY LIFE: Alkaline 200 hours, zinc-carbon 150 hours.
DIMENSIONS: 18.0 x 8.6 x 4.5 cm
WEIGHT: 480 g
SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.
FUNCTIONS: Voltage, current, resistance, conductance, temperature, continuity, level detection.
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V
DC AND AC CURRENT: 4 ranges, 2 mA to 2000 mA
RESISTANCE RANGE: 200R to 20M
DISPLAY: 3½ digit LCD
OTHER FEATURES: Audible continuity test, fully compensated direct temperature readings from 0°C for any K-type thermocouple, peak hold feature for transient signals, auto-zero, auto-polarity.

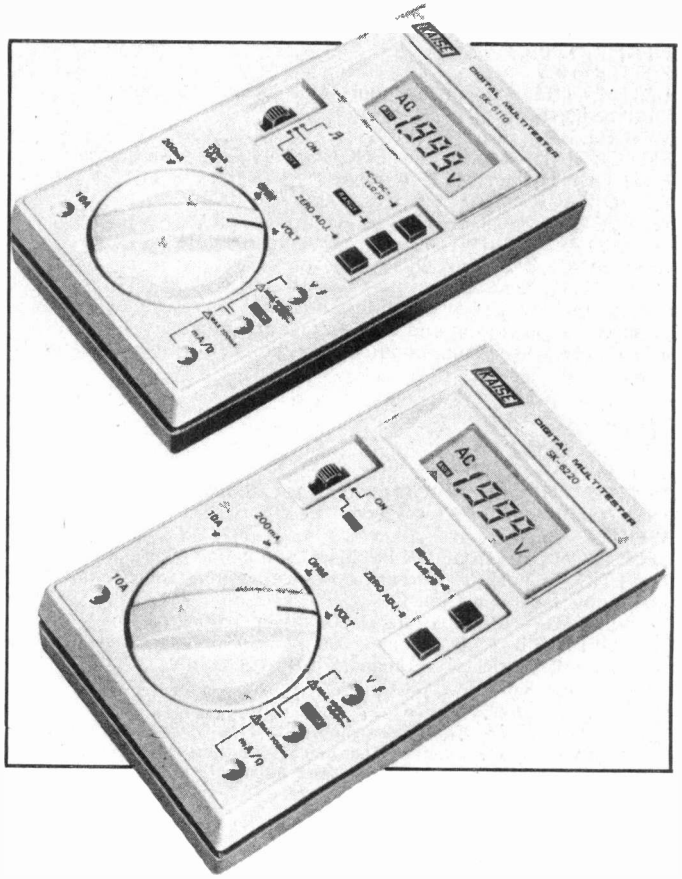
FLUKE 8010A/8012A (Bench Top)
PRICE: 8010A: £159.00
8012A: £199.00
BATTERY: Option of rechargeable NiCad batteries (-01) series)
BATTERY LIFE: 40 hours for DC voltage, 10 hours on other measurements.
DIMENSIONS: 6 x 22 x 25 cm
WEIGHT: 1.08 kg
FUNCTIONS: Current, voltage, resistance, conductance, high current
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, true RMS, 200 mV to 750 V
DC AND AC CURRENT: AC: 5 ranges, 200 uA to 2000 mA
DC: 4 ranges, 200 uA to 2 A
RESISTANCE RANGE: 6 ranges, 200R to 20M, 8021A low resistance 2R to 20R
DISPLAY: 3½ digit LCD
OTHER FEATURES: Battery low indicator, one year guarantee, auto-zero, auto-polarity, touch and hold, 8012A has two additional low resistance ranges.

FLUKE 8050A (Bench Top)
PRICE: £199.00
BATTERY: Rechargeable battery option (-01 series)
FUNCTIONS: Voltage (including AC voltage in true RMS, AC coupled) current, resistance, conductance, relative reference, direct readings in decibels. 39 measurement ranges.
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V
DC AND AC CURRENT: 5 ranges, 200 uA to 2000 mA
RESISTANCE RANGE: 200R to 20M
DISPLAY: 4½ digit LCD
OVERLOAD PROTECTION: Voltage: 750 V AC or 1000 V DC. Resistance: 300 V DC, short transients to 6 kV. 2 A fuse for current input plus heavy duty fuse.
OTHER FEATURES: Microprocessor control, DC accuracy of 0.3% for one year, safety indicator for input above 40 V.

HEWLETT PACKARD 3476A/3476B (Bench Top)
PRICE: 3476A: £126.00
3476B: £155
BATTERY: Rechargeable NiCad batteries with 3476B.
BATTERY LIFE: 8 hours with 3476B
DIMENSIONS: 5.8 x 16.8 x 20.6 cm
WEIGHT: A: 0.77 kg, B: 0.97 kg
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 100 uV to 1000 V
AC VOLTAGE RANGE: 3.3 mV to 700 V (RMS)
DC AND AC CURRENT: AC: 3.3 mA to 1.1 A
DC: 100 uA to 1.1 A
RESISTANCE RANGE: 1R0 to 11M
DISPLAY: LED
READING RATE: 3/S
OTHER FEATURES: Autorange, auto-polarity, auto-zero.

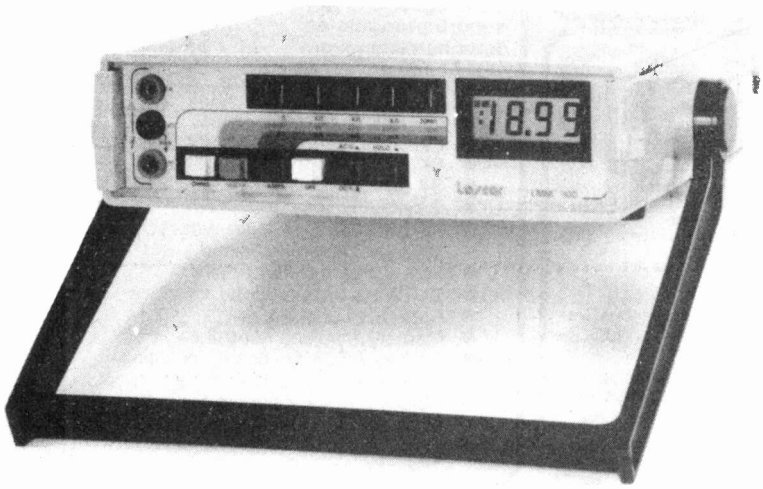
KAISE MODEL SK-6100, SK-6110
PRICE: SK-6110: £56.48, SK-6110: £65.17 ex VAT
BATTERY: Two 1.5 V, UM-3 or AA
BATTERY LIFE: 200 hours continuous operation.
DIMENSIONS: 155 x 85 x 28 mm
WEIGHT: 250 g
SELECTION OF RANGE OR FUNCTION: Rotary switch
FUNCTIONS: Voltage, current, resistance, low-power resistance.
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V auto ranging
AC VOLTAGE RANGE: 4 ranges, 2 V to 600 V
DC AND AC CURRENT: 20 mA to 200 mA
RESISTANCE RANGE: 200R to 2M0 and low power resistance 2k0 to 2M0.
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 10 mm
READING RATE: 2/S
OTHER FEATURES: Auto display, auto ranging, range hold function, overrange indication, battery low indicator, 0.5% accuracy, SK-6100 has continuity check with buzzer, SK-6110 has 10 A AC/DC range.

KAISE SK-6200, SK-6220
PRICE: SK-6200: £34.74, SK-6220: £43.43 ex VAT
BATTERY: Two 1V5 type UM-3 or AA
BATTERY LIFE: 200 hours continuous operation.
DIMENSIONS: 155 x 85 x 28 mm
WEIGHT: 250 g
SELECTION OF RANGE OR FUNCTION: Rotary switch
FUNCTIONS: Voltage, current, resistance and low power resistance.
DC VOLTAGE RANGE: 200 mV to 1000 V auto ranging
AC VOLTAGE RANGE: 2 V to 600 V auto ranging
DC AND AC CURRENT: 200 mA, SK-6220 only 10 A
RESISTANCE RANGE: 200R to 2M0
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 10 mm
READING RATE: 2/S
OTHER FEATURES: Full auto ranging, auto display, range hold function, overrange indication, 0.8% accuracy, battery low indicator. SK-6220 has 10 A AC/DC range.



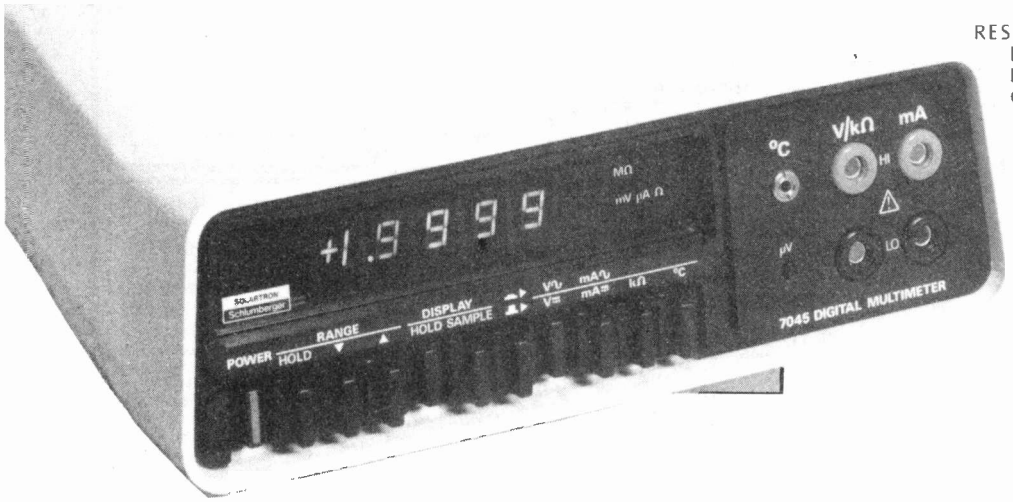
KEITHLEY 169 (Bench Top)
PRICE: £110.00 plus VAT
BATTERY: Six 1V5 "C" cells
BATTERY LIFE: 1,000 hours carbon-zinc, 2000 hours alkaline.
DIMENSIONS: 85 x 235 x 275 mm
WEIGHT: 1.4 kg
SELECTION OF RANGE OR FUNCTION: Colour-coded push button switches.
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
DC AND AC CURRENT: 5 ranges, 200 uA to 2000 mA
RESISTANCE RANGE: 6 ranges, 200R to 20M
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 0.6"
OVERLOAD PROTECTION: Voltage to 1400 V peak, resistance to 300 V RMS, current by 2 A fuse.
OTHER FEATURES: Auto-zero, out of range indication.

KEITHLEY MODEL 130
PRICE: £79.00 ex VAT
BATTERY: 9 V alkaline or carbon-zinc
BATTERY LIFE: Alkaline 200 hours, carbon-zinc 100 hours
DIMENSIONS: 178 x 78 x 38 mm
WEIGHT: 400 g
SELECTION OF RANGE OR FUNCTION: Rotation of two selector switches.
FUNCTIONS: Voltage, current, resistance
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V
DC AND AC CURRENT: 5 ranges, 2 mA to 10 A
RESISTANCE RANGE: 200R to 20M
DISPLAY: LCD
HEIGHT OF DISPLAY CHARACTERS: 0.6"
OVERLOAD PROTECTION: mA input: 2 A fuse (250 V) externally accessible; 10 A input: 20 A for 15 S unfused.
OTHER FEATURES: Auto-zero, auto-polarity, stand mounted, overrange indication.



LASCAR LM100 (Bench Top)
PRICE: £88.61
BATTERY: PP7
BATTERY LIFE: 2,000 hours
DIMENSIONS: 60 x 210 x 255 mm
WEIGHT: 1.2 kg
FUNCTIONS: 5 functions, 25 ranges
DC VOLTAGE RANGE: 6 ranges, 200 mV to 1000 V
AC VOLTAGE RANGE: 6 ranges, 200 mV to 1000 V
DC AND AC CURRENT: 6 ranges, 200 uA to 20 A
RESISTANCE RANGE: 200R to 20M
DISPLAY: 3½ digit LCD
HEIGHT OF DISPLAY CHARACTERS: 12.5 mm
READING RATE: 3/S
OTHER FEATURES: Auto-zero, auto-polarity, digital hold facility.

SOLARTRON 7045 (Bench Top)
PRICE: £360.00
BATTERY: 4 type D NiCad rechargeable (Optional)
DIMENSIONS: 200 x 70 x 260 mm
WEIGHT: 2.1 kg with batteries
FUNCTIONS: Voltage, current, resistance, temperature
DC VOLTAGE RANGE: 6 ranges, 19.999 V to 1000 V
AC VOLTAGE RANGE: 5 ranges, 199.99 V to 750 V
DC AND AC CURRENT: AC 6 ranges, 19.99 uA to 1999 mA
DC 6 ranges, 19.999 uA to 1999.9 mA
RESISTANCE RANGE: 6 ranges, 199 99R to 19.999M
DISPLAY: 4½ digit LED
READING RATE: 4/S
OTHER FEATURES: Battery low indicator, freeze display button, automatic ranging.



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A Z80 based S100 Computer System.

Available in Kit Form or Assembled. **All components available separately.**

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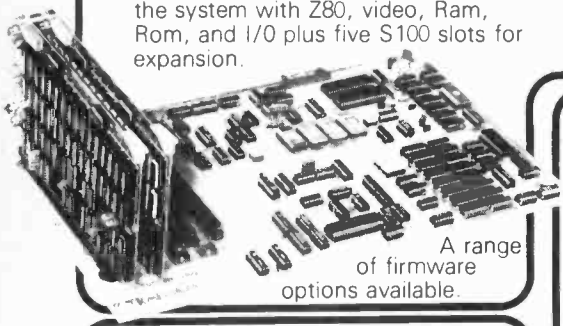

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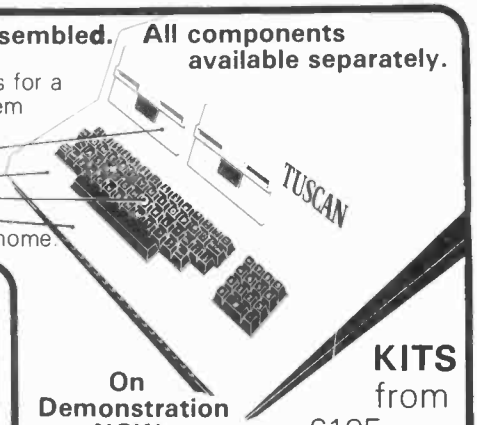

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Nascom 19" rack mounting card frame for N1 and N2	32.50
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MK36271 8K BASIC in 8K x 8 ROM	40.00
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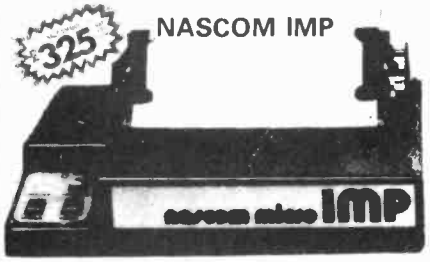

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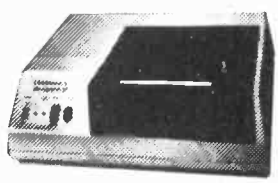

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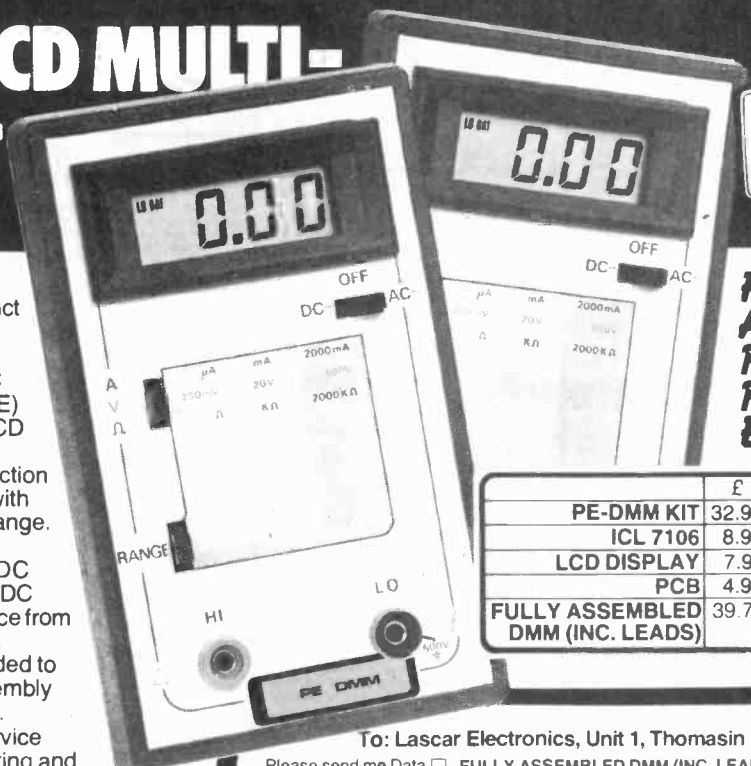

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7475	40p
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7490	35p
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74LS48	85p
74LS49	98p
74LS73	30p
74LS74	30p
74LS75	39p
74LS86	39p
74LS90	40p
74LS107	40p
74LS123	69p
74LS125	50p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS168	190p
74LS174	99p
74LS175	99p
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4015	75p
4016	35p
4017	60p
4018	76p
4019	42p
4020	88p
4021	100p
4022	88p
4023	22p
4024	50p
4025	20p
4026	130p
4027	45p
4028	75p
4029	80p
4030	50p
4031	195p
4033	145p
4035	104p
4036	290p
4037	105p
4038	110p
4039	290p
4040	99p
4041	75p
4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
4059	560p
4060	112p
4063	112p
4066	56p
4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4073	25p
4075	20p
4076	88p
4077	23p
4078	29p
4081	23p
4082	25p
4085	86p
4086	68p
4089	130p
4093	68p
4094	225p
4095	99p
4096	325p
4098	110p
4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	288p
4510	76p
4511	125p
4512	75p
4514	250p
4515	290p
4516	109p
4518	99p
4520	99p
4521	230p
4526	105p
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4531	150p
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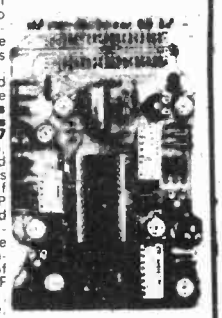

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NEW! AY-3-8910 Bang ZAP Clang Tweet

THE NEW GI COMPUTER SOUND CHIP

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VOLTAGE REGULATOR DESIGN

If you've got the DC DTs, Karl Wright comes to the rescue with this simple design to stabilise your supply

The function of a DC voltage regulator is to supply a constant DC voltage to a load from a specified range of input voltages. The basic circuit of the DC regulator is shown in Fig.1. This circuit is usable over a wide range of input and output voltages. The actual function of regulation is performed by sampling the DC output of the regulator by a potential divider, formed by R5, R6 and RV1 and comparing it, via Q2, with a reference voltage provided by ZD2 and R3, the potential difference being passed to the DC amplifier, also formed by Q2. The DC signal then passes to the control section, formed by Q3 and Q4, which makes the necessary adjustment to maintain the output voltage at the specified value. The remaining components, R1, R2, ZD1 and Q1, form a constant current source, which supplies the collector of the DC amplifier, Q2, and the base of the control section, Q3. C1 is included to prevent high frequency instability and R4 is included to provide a leakage current path and to allow low load current operation.

Design Procedure

In order to design the DC regulator to suit the individual requirement of a piece of equipment, the initial specifications must be defined as follows: — the output voltage required, $V_o = 40$ V DC, the maximum output current required, $I_o = 1A5$, the range of input voltages to be used, $V_{in}(min) = 45$ V DC, $V_{in}(max) = 60$ V DC, the operating temperature range, $T_{min} = 50°C$, $T_{max} = 125°C$ and the output resistance, $R_o \leq 0R25$.

The values shown for each of the parameters will be used in the calculations as an example. The first step is to determine the parameters of the transistors in the control section, Q3 and Q4.

$V_{ce4}(min) = V_{in}(min) - V_o = 45 - 40 = 5\,V$
$V_{ce4}(max) = V_{in}(max) - V_o = 60 - 40 = 20\,V$
$I_{e4}(max) = I_o = 1A5$
$P_{tot} = V_{ce4}(max) \times I_{e4}(max) = 20 \times 1.5 = 30\,W$

By reference to a semiconductor index the TIP29 is found to be adequate for this purpose. It also has a minimum value of $H_{fe} = 40$, which is used to determine the base current of Q4.

$$I_{b4} \leq \frac{I_{e4}}{H_{fe4}(min)+1} = \frac{1.5}{40+1} = 36.66\ mA$$

Q3 is selected by the following parameters;
$V_{ce3}(max) = V_{ce4}(max) - V_{be4} = 20 - 0.7 = 19.3\,V$
$I_{e3} = I_{b4} = 36.66\,mA$
$P_{tot\,3} \leq V_{ce3}(max) \times I_{e3} = 19.3 \times 0.03666 = 0.7075\,W$

By reference to a semiconductor index the BFY50 is found to be suitable for Q3. It also has a minimum value of $H_{fe} = 30$.

$$So,\ I_{b3} \leq \frac{I_{e4}}{(H_{fe4}+1)(H_{fe3}+1)} = \frac{1.5}{(40+1)(30+1)}$$

$$= \frac{1.5}{1271} = 1.18\ mA$$

I_{c1} is at least $= 2 \times I_{b3}$, thus $I_{c1} = 3$ mA and $I_{c2} \geq I_{b3}$. Using a silicon transistor for Q1 will allow the regulator to operate over the maximum temperature range, i.e. −50°C to +125°C. As Q1 is an PNP type, a BFX29 is chosen, with an $H_{fe(min)} = 50$ and $V_{be} = 1V0$. Therefore, if $I_{c1} = 3$ mA, $I_{e1} = I_{c1} + I_{b1} = 3 + 3/50 = 3.06$ mA.

V_{ZD1} is chosen as 2V7.

$$R2 = \frac{V_{ZD1} - V_{eb1}}{I_{e1}} = \frac{2.7-1}{3.06 \times 10^{-3}} = 555.56R \sim 560R$$

$$R1 = \frac{V_{in}(min) - V_{ZD1}}{I_{ZD1} + I_{b1}} = \frac{45-2.7}{(148+0.06)\times 10^{-3}}$$

$$= 285.69R \sim 300R$$

V_{ZD2} is not critical, so a value of 6V2 is chosen.

Current through ZD2 must be sufficient to maintain breakdown, thus a value of I_{ZD2} which is larger than I_{e2} is chosen, in this case 5 mA.

$$R3 = \frac{V_o - V_{ZD2}}{I_{ZD2}} = \frac{40-6.2}{5\times 10^{-3}} = 6760R \sim 6k8$$

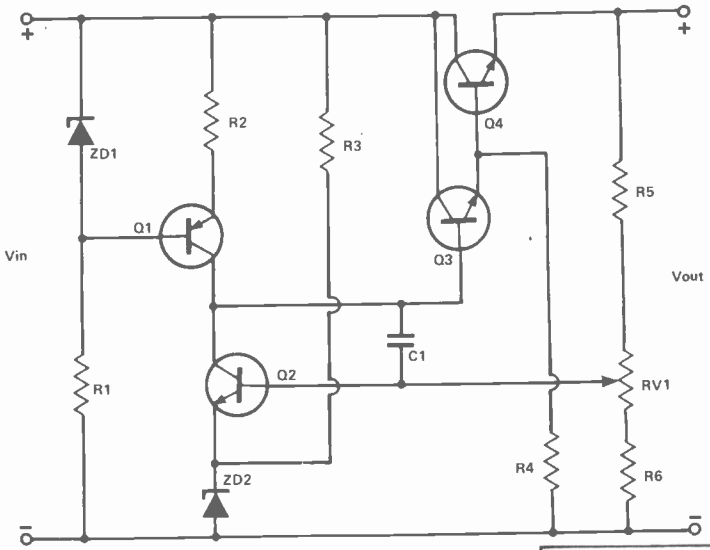
The collector current of Q2 will be approximately 3 mA, so a BFY50 is chosen for Q2.

RV1 is chosen as 250R and is a wire wound type. I_{R5} is chosen as 5 mA.

$$R5 = \frac{V_o - V_{be} - V_{ZD2}}{I_{R5}} = \frac{40-0.7-6.2}{5\times 10^{-3}} = 6620R \sim 6k8$$

$$R6 + RV1 = \frac{V_{be} + V_{ZD2}}{I_{R5}} = \frac{0.7+6.2}{5\times 10^{-3}} = 1380R$$

So, R6 = 1380 − RV1 = 1130R ∼ 1k2
C1 = 100nF
R4 = 33k



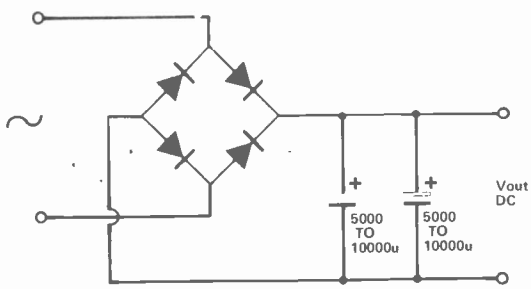
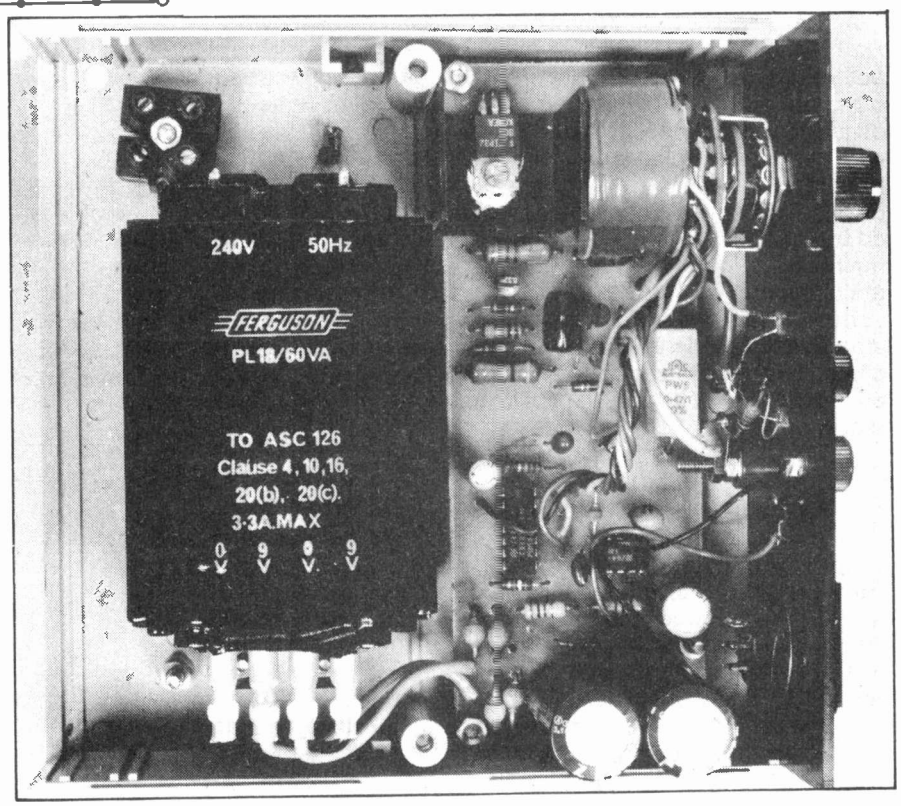


Fig. 1. (top) The basic circuit of the DC regulator.

Fig. 2. (above) This simple circuit will feed the regulator with a smoothed, but unregulated supply.

This is how professionals do it (right). This commercial power supply unit produces a regulated output voltage by the same principles as those on which the above simple design is based.



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It should be noted that with the TIP29 operating at 30 W it should be mounted on an adequately sized heatsink. Alternatively a higher power transistor could be used.

The regulator needs a relatively smooth input voltage. This can be supplied by the circuit shown in Fig.2. This is simply a standard full wave bridge rectifier circuit with a large reservoir capacitance.

The DC output from the circuit can be calculated by; V DC = 1.414 V AC.

The ripple output from the regulator is negligible as long as the ripple from the basic rectifier is relatively small, this being achieved by using a large reservoir capacitance.

If a high output voltage from the regulator is necessitated, then the positions of ZD2 and R3 should be interchanged, this being done to allow the transistor Q2 to operate at low levels irrespective of output voltage.

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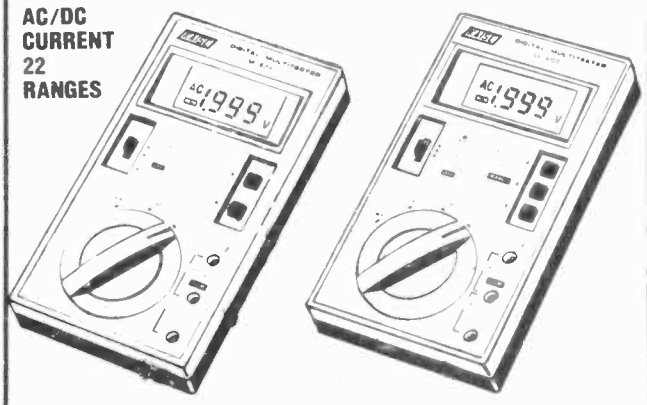

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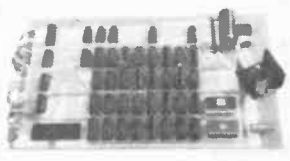

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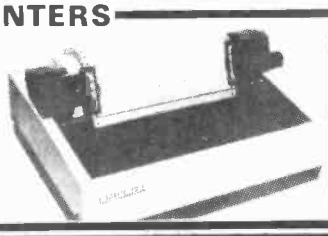

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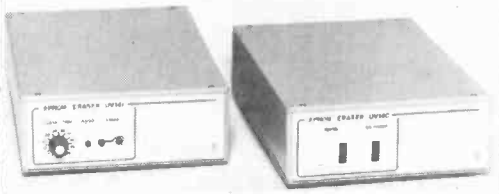

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4013	50p	4052	80p	40105	£1.85	4462	£4.41	4552	£14.85
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4015	84p	4054	£2.18	40107	£1.28	4490VP	£3.14	4554	£1.38
4016	45p	4055	£2.55	40108	£7.54	4500	£6.95	4555	78p
4017	80p	4056	£2.55	40109	£1.28	4501	29p	4556	72p
4018	89p	4059	£9.23	40110	£3.00	4502	£1.20	4557	£3.86
4019	45p	4060	£2.10	40114	£1.77	4503	70p	4558	£1.25
4020	99p	4062T	£10.00	40160	£1.54	4505	£5.71	4559	£4.38
4021	£1.10	4063	£1.90	40161	£1.54	4506	50p	4560	£2.50
4022	£1.00	4066	55p	40162	£1.54	4507	55p	4561	81p
4023	27p	4067	£7.21	40163	£1.54	4508	£2.90	4562	£5.60
4024	78p	4068	27p	40174	£1.54	4510	99p	4566	£1.59
4025	27p	4069	27p	40181	£5.03	4511	£1.50	4568	£2.38
4026	£3.25	4070	30p	40182	£1.90	4512	80p	4569	£2.50
4027	50p	4071	25p	40192	£2.41	4514	£2.65	4572	40p
4028	84p	4072	25p	40193	£2.41	4515	£3.00	4580	£4.77
4029	99p	4073	25p	40194	£3.27	4516	£1.10	4581	£2.62
4030	74p	4075	25p	40208	£7.54	4517	£4.46	4582	£1.14
4031	£4.31	4076	£1.07	40257	£2.31	4518	£1.00	4583	90p
4032	£1.31	4077	29p	4160	98p	4519	80p	4584	90p
4033	£2.63	4078	29p	4161	98p	4520	£1.00	4585	£1.27
4034	£2.00	4081	27p	4162	98p	4521	£2.50	4597	£2.44
4035	£1.10	4082	27p	4163	98p	4522	£1.11	4598	£2.98
4037	£1.99	4085	£1.35	4174	90p	4526	£1.08	4599	£6.95
4038	£1.20	4086	£1.35	4175	£1.15	4527	£1.50	4700	£1.75
4039	£2.78	4089	£2.91	4194	£1.16	4528	£1.20		
4040	£1.00	4093	80p	4408	£9.37	4529	£1.30		
4041	£1.59	4094	£2.50	4409	£9.37	4530	70p		

74C

74C00	28p	74C76	57p	74C163	£1.15	74C903	57p	74C925	£5.01
74C02	28p	74C83	£1.34	74C164	£1.08	74C904	57p	74C926	£5.01
74C04	28p	74C85	£1.34	74C165	£1.08	74C905	£7.53	74C927	£5.01
74C08	28p	74C86	57p	74C173	93p	74C906	57p	74C928	£5.01
74C10	28p	74C89	£4.62	74C174	93p	74C907	57p	74C929	£17.90
74C14	90p	74C90	89p	74C175	93p	74C908	£1.00	74C930	£17.90
74C20	28p	74C93	89p	74C192	£1.15	74C909	£1.69		
74C30	28p	74C95	£1.08	74C193	£1.15	74C910	£7.45	80C95	85p
74C32	28p	74C107	£1.27	74C195	£1.08	74C911	£7.39	80C96	92p
74C42	95p	74C150	£3.81	74C200	£7.46	74C912	£7.39	80C97	85p
74C48	£1.43	74C151	£2.55	74C221	£1.41	74C914	£1.46	80C98	92p
74C73	57p	74C154	£3.81	74C245	£2.98	74C915	£1.15	82C19	£6.20
74C74	59p	74C157	£2.29	74C373	£1.79	74C918	£1.10	88C29	£2.90
		74C160	£1.49	74C374	£1.79	74C921	£17.07	88C30	£2.90
		74C161	£1.15	74C901	57p	74C922	£3.78		
		74C162	£1.15	74C902	79p	74C923	£3.86		

MODULATORS

UM1111 E36 UHF Ch.36 Vision Modulator £2.50

UM1231 UHF Ch.36 Vision Modulator wide handwidth (for computers etc.) £4.70

UM1263 FM Sound Subcarrier Modulator £2.50

SWITCH MODE PSUs

AC 5221S 5V/10A £69.90

AC 9221S 5V/5A, 12V/1A, −12V/1A, −5V/0.1A £86.80

AC 5421S 5V/20A £99.20

AC 9421S 5V/10A, 12V/2A, −12V/2A, −5V/0.1A £126.50

MICROPROCESSORS

COMPUTER BOARDS

114 x 203 mm fibreglass, gold plated edge connector. Buffered SC/MP CPU £9.40

SC/MP Prototboard	£9.40
Z80 CPU card	£9.40
VDU 'A' } set	£8.90
VDU 'B' } of	£8.90
VDU 'C' } three	£9.40
EPROM Programmer (2708s)	£9.40
4k PROM board (5204s)	£9.40
8k PROM board (2708s)	£9.40
2k RAM board (2102s) 1k-2k	£9.40
8k RAM board (2114s) 1k-8k	£9.40
Tape interface	£8.90
Keyboard interface	£8.90
PSU 5v, +12v, −12v board	£8.90
PSU 5v, −12v board	£5.50
ISBUS 1.1 13 slot back-board	£11.50

13"×14¾" approx. Epoxy Glass, tinned

Further details on request

Z80

Z80 CPU (2½MHz)	£9.90
Z80-CTC (2½MHz)	£5.95
Z80-PIO (2½MHz)	£6.60

(Add £1 for the 4MHz version of any of the above 3 chips.)

SC/MP II RAM I/O

SC/MP II (4MHz)	£10
INS 8154 RAM I/O	£9.40

6800

6800 MPU	£6.55
6802 MPU	£9.95
6810 (128 × 8 RAM)	£3.25
68A10 (128 × 8 RAM)	£3.75
6820, 6821 PIA	£3.96
6850 ACIA	£4.85
MC6880	£2.64

6502

6502	£7.95
6520 PIA	£6.22
6522	£7.95

CMOS

COSMAC CDP 1802CE	£6.50
COSMAC CDP 1802E	£10.85
CDP 1864	£7.25

STATICS (Mostly 450nS)

2101—256 x 4	£2.25
2102—1K x 1	£1.20
2111—256 x 4	£1.95
2112—256 x 4	£2.25
2114/4045—1K x 4	£4.39
8 x 2114	£28.00
2114L—1K x 4	£5.50
4118—1K x 8	£15.50

DYNAMICS

MK 4116 16K 250nS	£4.95
MK 4816 2K x 8	£30.52

UV ERASABLES

5204 (512 x 8)	£11.50
2708 1K x 8	£6.75
2716/2516 2K x 8 single 5v	£17.95
2532 4K x 8 (5v)	£47.00

PROM WASHING each Prom 50p (+30p+VAT)

UV PROM ERASER

UV140	£61.20
UV141	£77.70

INTERFACE

81LS95/6/7/8	£1.40
75491 LED driver	50p
75492	92p
ZN425	£3.95
8T26/8T28	£2.64
IL74	48p

CRT Controller: Uarts

Thompson CSF SF.196364E	£11.50
AY-5-1013 UART TR 1602	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.60
AY-3-1015	£5.60

CHAR. GEN. KEYBOARD ENCODER

MCM 66760	£9.75
MK 2302	£15.29
KO-3-2513 (5v Uppercase)	£6.00
DM 8678 CAB/BWF	£14.27
AY-5-2376	£9.75

FIRMWARE

ZMON for Z80 (1 x 2708)	£14.95
2K Tiny BASIC for Z80 (2 x 2708)	£19.95
4K NIBL for SC/MP (4 x 2708)	£49.95
4K NIBL-MM for SC/MP (4 x 2708)	£49.95
1K Various, for SC/MP (1 x 2708)	£14.95

(Descriptive leaflet available on above, Ref SW4. 5)

IK Elektor Junior 1x2708	£19.95
1½K ELBUG (3 x 5204)	£35.00
ETIBUG 1 (1 x 5204)	£14.95
ETIBUG 2 (1 x 5204)	£14.95
SCMP/KB (1 x 5204)	£14.95

QUARTZ

32.768KHz (Watch)	£3.23
60 KHz	£9.95
100.0 KHz	£3.62
200.0 KHz	£3.92
204.8 KHz	£3.92
262.144 KHz	£3.92
307.2 KHz	£3.92
312.5 KHz	£3.92
455.0 KHz	£4.95
1.000 MHz	£3.62
1.008 MHz	£3.92
1.280 MHz	£3.92
1.8 MHz	£4.25
1.8432 MHz	£3.62
2.000 MHz	£3.62
2.097152 MHz	£3.23
2.4576 MHz	£3.62
2.500 MHz	£3.92
2.56250 MHz	£3.62
3.000 MHz	£3.62
3.2768 MHz	£3.23
3.579545 MHz	£1.95
3.93216 MHz	£3.92
4.000 MHz	£2.90
4.032 MHz	£3.23
4.096 MHz	£3.23
4.194304 MHz	£3.23
4.433619 MHz	£1.25
4.608 MHz	£3.23
4.800 MHz	£3.23
4.9152 MHz	£3.23
5.000 MHz	£3.23
5.0688 MHz	£3.23
5.120 MHz	£3.23
5.185 MHz	£3.23
6.000 MHz	£3.23
6.144 MHz	£3.23
6.400 MHz	£3.23
6.55360 MHz	£3.23
7.000 MHz	£3.23
7.168 MHz	£3.23
7.680 MHz	£3.23
7.86432 MHz	£3.23
8.000 MHz	£3.23
8.388608 MHz	£3.23
8.867237 MHz	£3.23
9.375 MHz	£3.92
9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.432 MHz	£3.23
20.000 MHz	£3.62
20.1134 MHz	£3.23
25.690 MHz	£2.10
27.0 MHz	£3.92
27.145 MHz	£2.10
27.648 MHz	£3.92
38.6666 MHz	£3.23
48.000 MHz	£3.23
100.000 MHz	£3.23
116.000 MHz	£3.23

VEROBOARD

0.1" Pitch with copper strips

2½"×1" (pack of 5)	74p
2½"×3¾"	53p
2½"×5"	62p
2½"×17"	£1.86
3¾"×3¾"	62p
3¾"×5"	69p
3¾"×17"	£2.40
4.7"×17.9"	£3.14

0.1" Plainboard (no strips)

3¾"×2½"	38p
3¾"×5"	59p
3¾"×17.0"	£1.56
Terminal pins	£1.50/500
V-Q DIP board	£1.17
DIP breadboard	£2.91
Spot face cutter	93p
Pin insertion tool	£1.28

SOLDERCON PINS

100 50p 1000 £3.95

DIL SOCKETS

8/14/16 pin	10p/12p/13p
18/20/22 pin	18p/20p/25p
24/28/40 pin	30p/40p/50p

24 pin Textool lever type zero insertion force £8.50

EDGE CONNECTORS

43 way, 0.1" pitch, wire wrap, polarizing slot pin 37

Single sided (1×42) £3.11

Double sided (2×42) £4.10

TIMER ICs

NE555/556 29p/49p

OP-AMPS (All Mini dips)

CA 3130E	84p
CA 3140E	35p
UA 741 (Texas)	22p

4 DIGIT LED DISPLAY

Multiplexed, common cathode, prime quality. NSB 5881 (0.5) £5.75

LED DISPLAYS

OL-704E	99p
OL-727E/728E	£2.00
OL-747E/750E	£1.80
FND 500/560	£1.20

LIQUID CRYSTAL DISPLAY

4×0.5" Digits 40 pin DIL £9.95

CLOCK CHIPS

AY-5-1224A	£2.60
MK 50253	£5.50
MK 50366	£6.50

SIX DECADE COUNTERS

MK 50395/6/7	£9.90
MK 50398/9	£7.50

DATA

Note: in this section all data books are subject to 0% VAT. For postage see 'Terms' at top of page.

113 page Electronic Projects Index 72-77 (North Tyneside Libraries)	£1.50
c650 page COSMOS Databook (RCA)	£4.95
c31 page 'A Guide to SC/MP Programming' by Dr. Drury (Kemitron)	£3.75
c20 page 'A Guide to Kitbug' (Kemitron)	75p
c24 page NIBL Reference Guide (National)	£3.45
Data for 4116 (Mostek)	50p
c6 page data for Mk 4118	25p
16-page data for IMS 8154 (ISP-8A/650) (National)	50p
20-page data for SC/MP II (National)	50p
c100 page CDP 1802 MPU User Manual (RCA)	£4.50
c45 page Fixed Point Binary Arithmetic Routines for COSMAC	£4.50
c31 page Floating Point Arithmetic Routines for COSMAC (listings excluded)	£4.50
c43 page COSMAC MPU Product Guide (RCA)	75p
c15 page CDP 1802 Instruction Summary	25p
c70 page Understanding CMOS (RCA)	£1.50
1 page COSMOS Pocket Selection Guide (RCA)	25p
c21 page COSMOS Digital Integrated Circuits (RCA)	75p

Z80 DATA PACK £14.95

This contains all the data we can obtain on the Z80 CPU and related chips, and the Z80 Programming Manual. Depending on our own supplier, the data is either loose sheets, photocopies or bound volumes, or a combination of both. The weight of the set of data is about 1½ kilos, and some information on other processors, memories, and systems is often included.

c50 page Finite State Fantasies (Cartoons getting programming on human level) (Matrix Press)	£2.00
c175 page Home Computers: Beginners Glossary and Guide by Miller and Sippl (Ohlithium)	£4.95

74LS

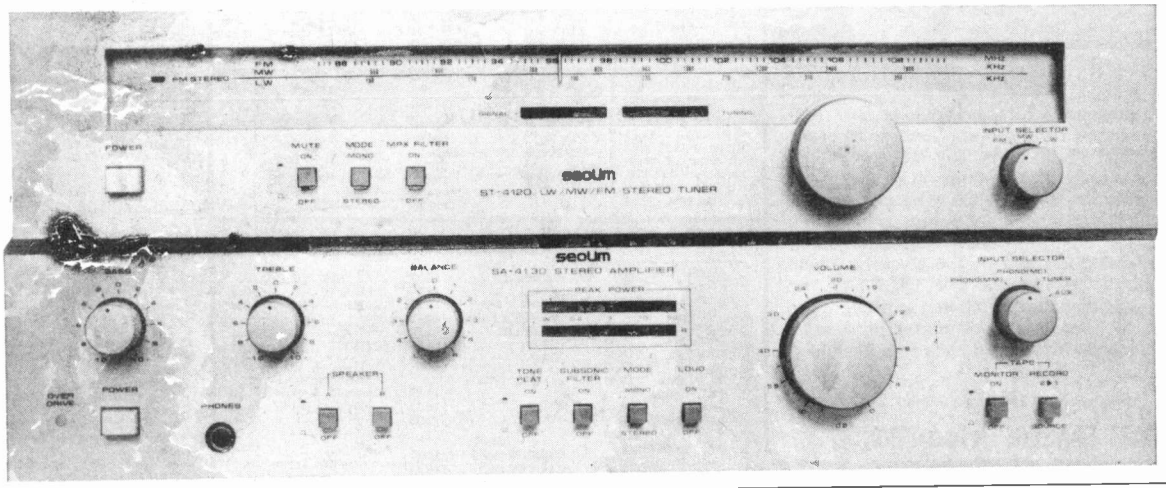
74LS00	14p	74LS27	28p	74LS76	40p	74LS125	60p	74LS163	£1.18	74LS240	£2.36	74LS283	£1.92	74LS375	£1.60
74LS01	14p	74LS28	48p	74LS78	40p	74LS126	60p	74LS164	£1.14	74LS241	£2.32	74LS290	£1.28	74LS377	£2.12
74LS02	16p	74LS30	22p	74LS83	£1.15	74LS132	95p	74LS165	75p	74LS242	£2.32	74LS293	£1.28	74LS378	£1.84
74LS03	16p	74LS32	27p	74LS85	£1.18	74LS136	55p	74LS166	£2.26	74LS243	£2.32	74LS295	£1.85	74LS379	£2.15
74LS04	16p	74LS33	39p	74LS86	43p	74LS138	85p	74LS170	£2.88	74LS244	£1.70	74LS298	£1.68	74LS384	86p
74LS05	20p	74LS37	39p	74LS90	60p	74LS139	85p	74LS173	£1.05	74LS245	£3.50	74LS324	£2.40	74LS386	86p
74LS08	22p	74LS38	39p	74LS91	£1.04	74LS145	£1.08	74LS174	£1.06	74LS247	£1.90	74LS325	£2.90	74LS390	£2.30
74LS09	22p	74LS40	28p	74LS92	89p	74LS147	£1.70	74LS175	£1.10	74LS248	£1.90	74LS326	£2.94	74LS393	£2.30
74LS10	20p	74LS42	98p	74LS93	89p	74LS148	£1.73	74LS181	£3.98	74LS249	£1.90	74LS327	£2.86	74LS395	£2.18
74LS11	22p	74LS47	90p	74LS95	£1.16	74LS151	96p	74LS183	£2.98	74LS251	£1.34	74LS347	£1.48	74LS396	£2.15
74LS12	23p	74LS48	£1.20	74LS96	£1.16	74LS153	76p	74LS190	£1.40	74LS253	£1.42	74LS348	£1.86	74LS398	£2.76
74LS13	38p	74LS49	£1.20	74LS107	44p	74LS154	£1.70	74LS191	£1.40	74LS257	£1.10	74LS352	£2.28	74LS399	£2.30
74LS14	75p	74LS51	24p	74LS109	55p	74LS155	96p	74LS192	£1.30	74LS258	£1.46	74LS353	£2.28	74LS445	£1.50
74LS15	30p	74LS54	28p	74LS112	55p	74LS156	96p	74LS193	£1.30	74LS259	£1.60	74LS365	65p	74LS447	£1.44
74LS20	20p	74LS55	30p	74LS113	50p	74LS157	76p	74LS194	£1.66	74LS261	£4.50	74LS366	65p	74LS490	£1.80
74LS21	22p	74LS63	£1.50	74LS114	50p	74LS158	96p	74LS195	£1.36	74LS266	52p	74LS367	65p	74LS668	£1.82
74LS26	48p	74LS73	46p	74LS122	70p	74LS160	£1.28	74LS196	£1.00	74LS273	£2.44	74LS368	66p	74LS669	£1.82
		74LS74	41p	74LS123	70p	74LS161	98p	74LS197	£1.40	74LS275	£2.50	74LS373	£1.80	74LS670	£2.48
		74LS75	48p	74LS124	£1.80	74LS162	£1.38	74LS221	96p	74LS279	66p	74LS374	£1.95		

HI-FI SYSTEM OFFER

This month we present the biggest and best ETI readers' offer ever — a complete hi-fi system. We've torn up its normal price tag of over £300 and slapped on our own — £279 including VAT and postage. Available only to ETI readers.

The system, imported by Videotone, bears a name unfamiliar to British Audiophiles — Seoum. The loudspeakers bear the familiar Videotone badge.

What do you get for your money? A slimline 30 W per channel stereo amplifier with moving coil input, an AM/FM stereo tuner and matched cassette deck with Dolby NR (naturally) and selectable bias and equalisation. A pair of the excellent Videotone GB2 loudspeakers completes the system. Just look at the technical specifications.



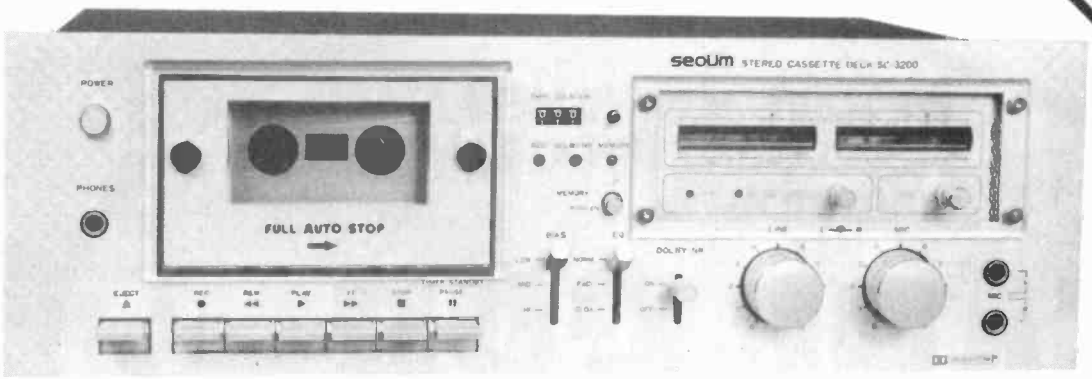
TUNER SPECIFICATION

FM Section — Tuning Range 87.5-109 MHz **Sensitivity** IHF/75R 0.8uV **Selectivity** IHF/200 kHz 95 dB **Capture Ratio** 1.2 dB
T.H.D. Mono 0.08% Stereo 0.15% **S/N Ratio** Mono 85 dB Stereo 80 dB
AM Section — Tuning Range 525-1650 kHz **Sensitivity** IHF/75R 10uV **Selectivity** IHF/75R 45 dB **T.H.D.** 0.8%
Dimensions 430(W) x 285(D) x 184(H) mm
FEATURES: 0.8uV (9.3 dBf) FM sensitivity; New MPX circuit with pilot signal cancelling improves FM frequency response up to 18 kHz within ± 1dB; New FM detector quadrates FM S/N

AMPLIFIER SPECIFICATION

Audio Section — Output Continuous RMS driven at 20-20,000 Hz 8R 30 + 30 W **Peak Output** 100 W + 100 W **T.H.D.** at rated output 20-20,000 Hz 0.03% **Frequency Response** 8—60 kHz **S/N Ratio** Phono 1 (MM) 82 dB **IHF "A" Weighted** Phono 2 (MC) 70 dB Aux 102 dB **Input Sensitivity** Phono 1 (MM) 2.2mV/47k Phono 2 (MC) 0.2m V/0.1 k Aux 125mV/50k
Speaker Impedance 4, 8, 16 R
FEATURES 30 W + 30 W Output power at 0.03% THD from 20Hz to 20kHz; Quickest electronic overload protection circuit with Green (normal) Red (protected) LED indicator; Super low noise EQ amp for moving coil and moving magnet cartridge; Tape dubbing facility · 12 dB/Oct subsonic filter.

Under £300!



CASSETTE RECORDER SPECIFICATION

1. Frequency Response (Dolby NR OFF) Cr O_2 Tape 30—16,000 Hz FeCr Tape 30—16,000 Hz Normal Tape 30—15,000 Hz **2. S/N Ratio (From Dolby level)** Normal Tape; Flat 52 dB Weighted NR OFF 53 dB Weighted NR ON 62 dB Fe Cr & Cr O_2 Tape; Flat 56 dB Weighted NR OFF 58 dB Weighted NR ON 67 dB **3. Harmonic Distortion (Normal Tape)** 0.5% **4. Cross Talk 1 kHz** 55dB **5. Erasure Effect** 75 dB **6. Bias Frequency** 100 kHz **7. Wow & Flutter Weighted** 0.05% **8. Fast Forward time** (C-60) 75 S **9. Rewind time** (C-60) 75 S **10. Input Sensitivity** LINE 60 mV MIC 0.25 mV DIN 8.25 mV **11. Output level** 0-1 V

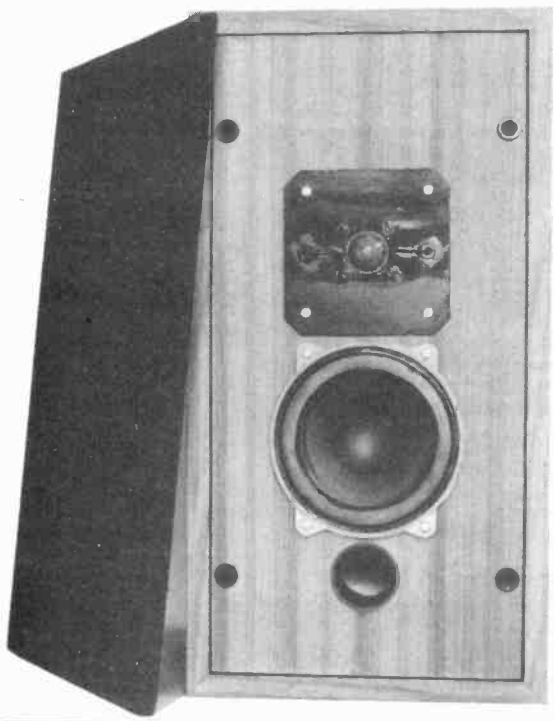
EQ & BIAS SELECTOR Equipped with EQ & Bias 3-position selector switch that can always keep the best recording and playing conditions for any tape used.

PEAK INDICATOR Generally a VU meter can't respond to transient sounds, so it can't indicate these sounds accurately. The peak indicator indicates them precisely, so preventing distortion and making an overall better recording.

FEATURES: Dolby system front loading stereo cassette deck; New LED VU meter indicating peak level; Selector checking recording & playback level and output level; Full auto-stop and memory function; Output level control volume; FET pre-amplification; 3-position selector of bias and E.Q.; Built-in Dolby NR circuits; Recording mixing facility; Low wow-flutter and distortion; Electronic timer stand by protecting pinch roller.

GB2 LOUDSPEAKERS SPECIFICATION

Type: Port loaded, two way, floorstanding/bookshelf model. **Recommended Amplifier power:** 15-40 W. In general they need between 10 and 15 W RMS per channel for every 1000 cu ft of room space. **Impedance:** 8 R nominal. **Frequency Response:** 50 Hz to 20 kHz ± 5 dB. **Efficiency:** 8V8 gives 90 dB. **Distortion:** Less than 1% 60 Hz to 20 kHz for 5 V input. **Finish:** Teak foil with black frets. **Size:** 19" high, 10" wide and 11" deep. **Weight:** 22 lbs each.



- **Amp has moving coil input!**
- **Peak power delivery of over 75W per channel!**
- **Tuner has high sensitivity and selectivity**
- **Cassette deck uses accurate LED indication**
- **Guaranteed system compatability for clear sound**

Please send me ..... **Seoum hi-fi system(s)**

I enclose a cheque for £ ..... **(£279 per system)**

Name .....

Address .....

.....

Send your order to: Modmags Ltd. (Sales Office), 145 Charing Cross Road, London WC2H 0EE

ETIPRINTS

ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

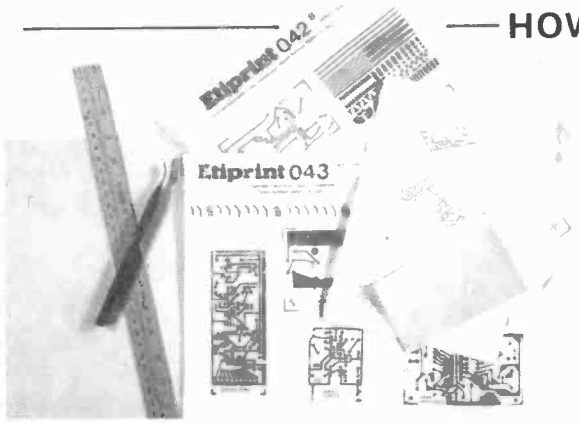
ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

Shown below is the listing for the last year's ETIPRINTS.

PARTS LIST

038	Buffer Moving Coil Preamp Process Controller	Jan 80	**040B**	ETI 80 – PSU Tuning Fork Filter Coin Toss	Feb 80	**042B**	Touch Dimmer, Battery Charger RC Guardian (Top,Bottom)1&2	Apr 80
039A	Hum Filter Logic Probe	Dec 79	**041A**	ETI Audiophile ETI VCA Signal Trace ETI HC Electromyogram	Mar 80	**043**	IR60 preamp, Receiver, PSU, Servo Tester, VU – PPM	May 80
039B	Long Period Timer Rain Alarm Touch Switch Flash Trigger Pseudo Random Noise Gen	Dec 79	**041B**	VCM Heater Controller	Mar 80	**044A**	IR60 Function Board (Top & underside) Control Circuit, Line Transmitter, Tape Response Meter Ohmmeter	June 80
039C	Function Generator	Dec 79	**042A**	300W Amp Module	Apr 80			
040A	ETI 80 – VCO and VCLFO	Feb 80	**033**	Fuel Level Monitor, Alarm, Screen Controller Dynamic Noise Reducer	Sep 79	**044B**	FM receiver PSU & Monitor Amp Drum Synth (function board)	June 80

HOW IT WORKS



Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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ETIPRINTS

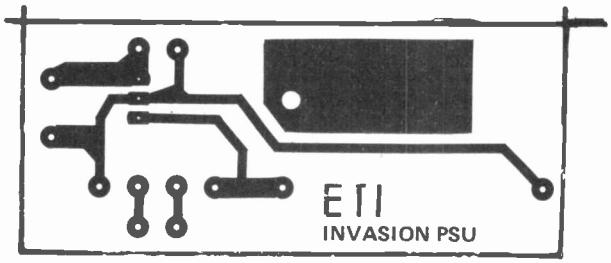
PCB FOIL PATTERNS

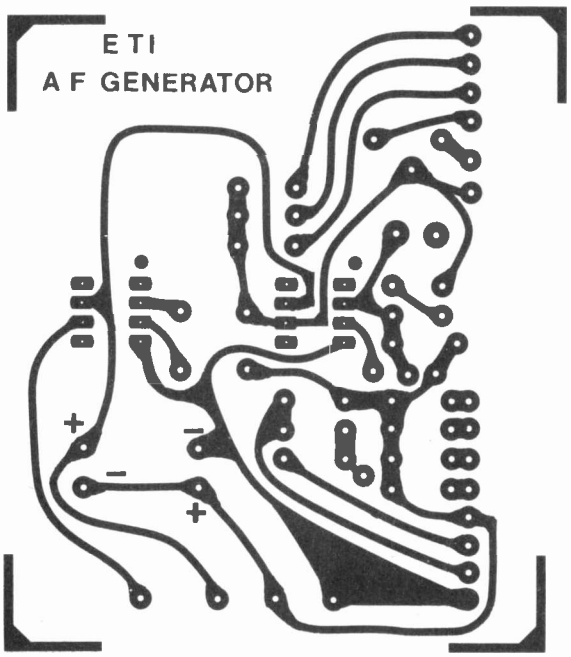
The double sided main board (copyright Tangerine Computers Limited) is not shown. The sound effects board will be shown next month.

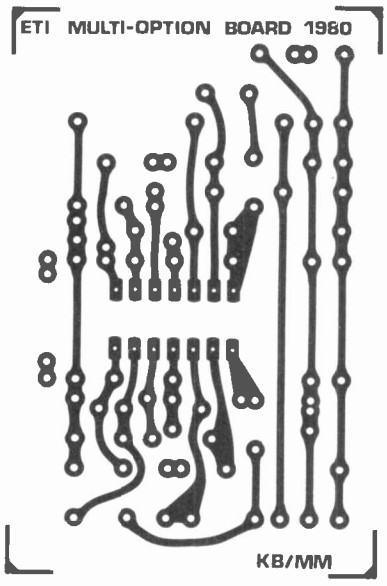
A heatsink as described in the Space Invasion article must be used with the project's power supply (foil pattern right) or the unit will overheat and cease operation.

Bottom right: The ETI Multi-Option Board can be used for all five projects.

Below: Audio Test Oscillator.







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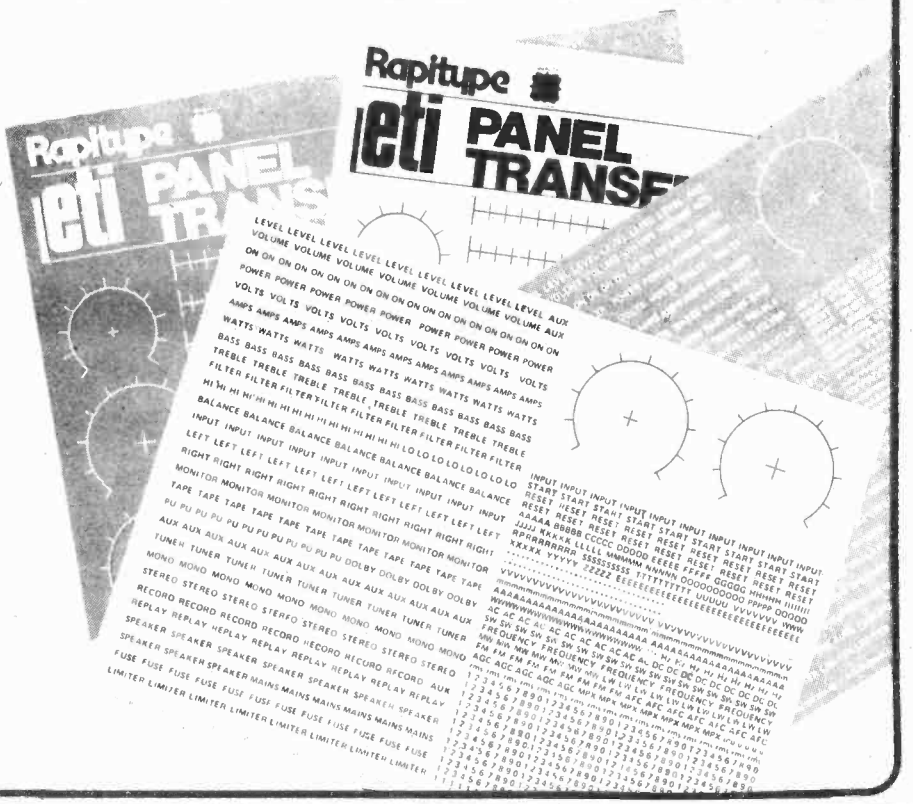

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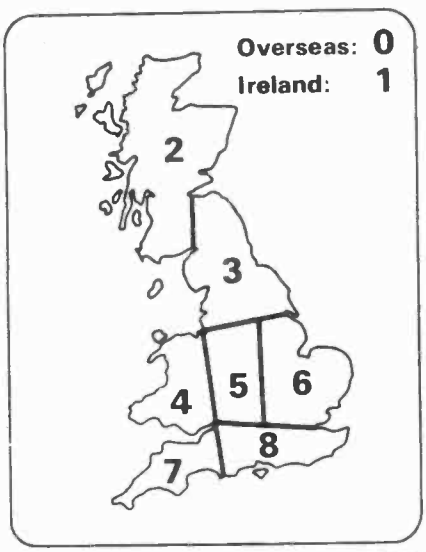

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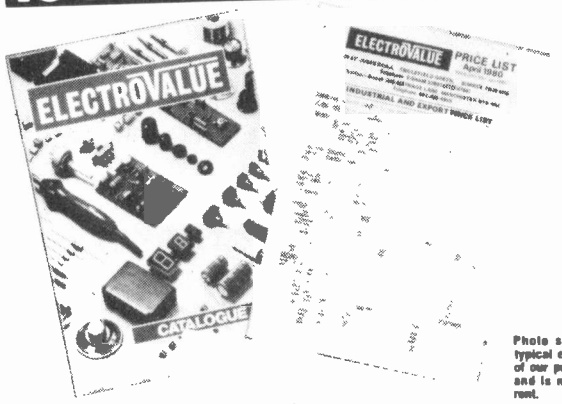

Photo shows a typical example of our price list, and is not current.

It's Electrovalue's quarterly price list published to keep you up-dated on price and item variations in our 128 page catalogue (FREE ON REQUEST). If you are not yet a customer on our regular mailing list, we will send you our current price list FREE on request and a catalogue (No. 10) with it as well if you wish.

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EXAMPLE TWO - PRINTED CIRCUIT MATERIALS

PCB's 300 x 150 mm		Etch Resist Pen	**£1.21**
5SHBP S/S **£1.38**	D/S **£1.73**	Breadboards	
F/Glass S/S **£2.19**	D/S **£2.48**	Bimboard 12	**£9.23**
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EXAMPLE THREE - SWITCHES

Chrome toggle		13A time switch adaptors Smiths TS 100	**£14.43 net**
Std. SPST **65p**	DPDT **89p**	Wavechange, Lorlin, 1P12W, 2P6W	
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Polyester 7.5mm PCM
1, 1.5, 2.2, 3.3, 4.7nf, 10, 15, 22, 33, 47nF **8p each**, 0.1µ **12p**, 0.15µ **15p**, 0.22µ **18p**, 0.33µ **21p**, 0.47µ **27p**, 0.68µ **34p**, 10mm PCM 1µ **37p**.

Electrolytic axial (µF/V)
1/40 **15p**, 1/100 **12p**, 2.2/25 **15p**, 2.2/63 **12p**, 4.7/16 **15p**, 4.7/40 **12p**, 10/25 **12p**, 10/40 **13p**, 22/25 **13p**, 22/40 **16p**, 22/63 **19p**, 47/10 **13p**, 47/25 **16p**, 47/40 **19p**, 47/63 **20p**, up to 1000/16V **32p**, Then 1000/25V **44p**, etc.

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EXAMPLE SIX - RESISTORS

⅓, ½, ¾W **2.3p** 1W **6p**. Wirewound from **23p**

AND AS FOR SEMI CONDUCTORS . . .

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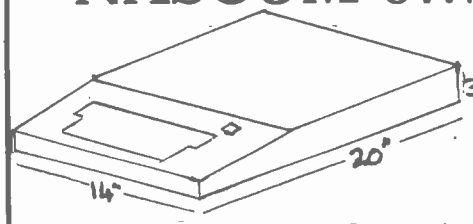

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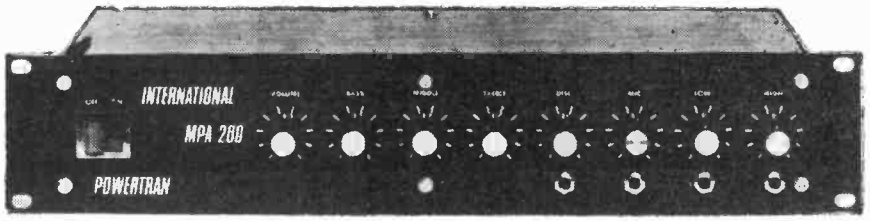
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" x 3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90 + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

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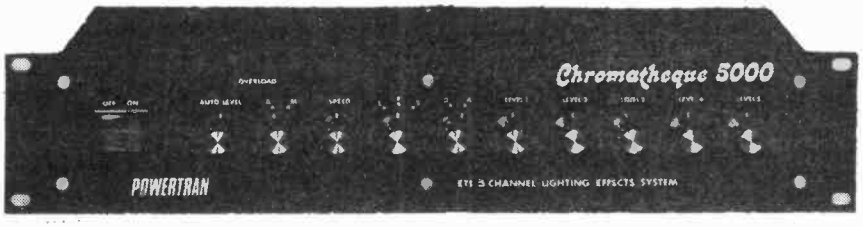
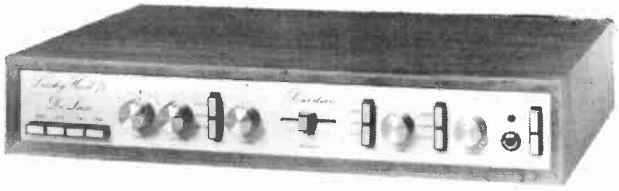


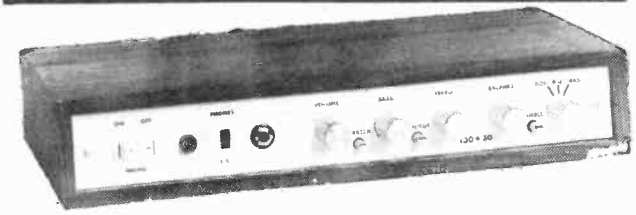
Panel size 19.0" x 3.5". Depth 7.3"

POWERTRAN

SYNTHESIZER KITS ON PAGE 9. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.

All kits also available as separate packs (e.g. PCB, component sets, hardware sets, etc.). Prices in our FREE CATALOGUE.





DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

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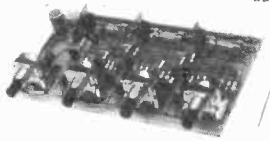

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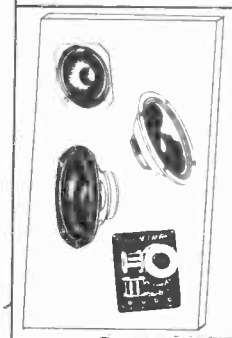

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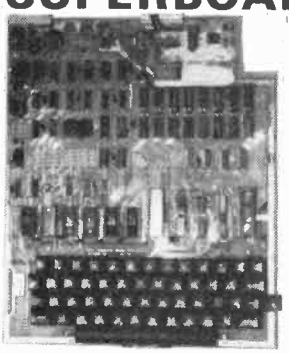

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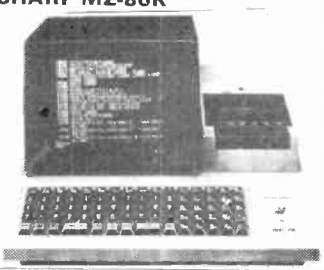

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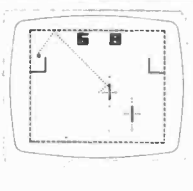

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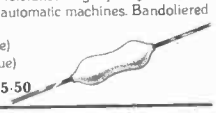

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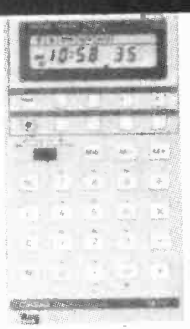

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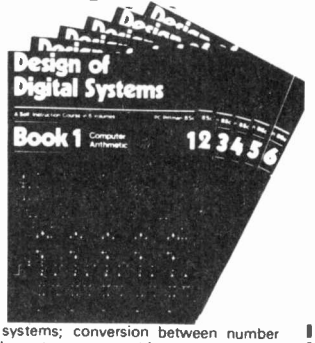

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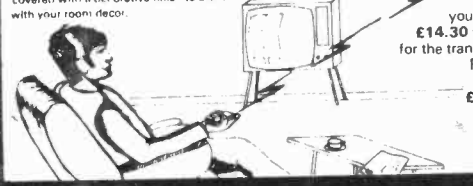

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S9263 Touchswitch 16-way	£4.85
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All ICs supplied with data sheets
Data Sheets only 10p each device.

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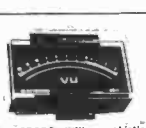

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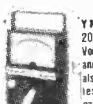

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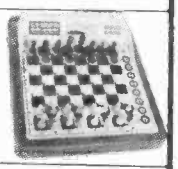

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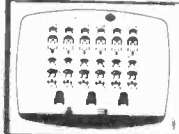

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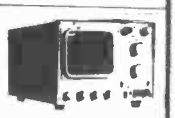

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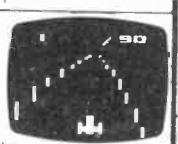

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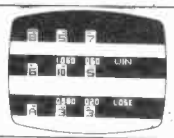

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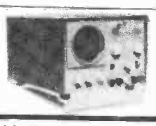

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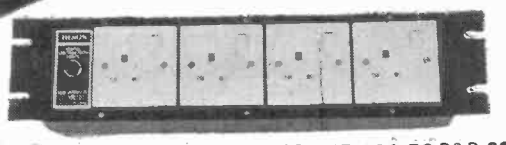

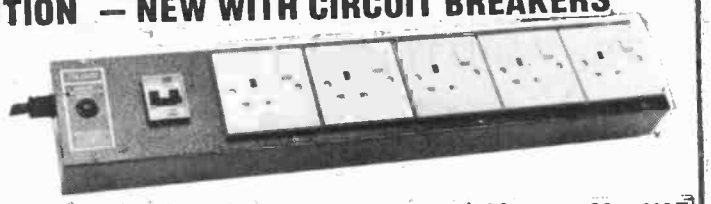

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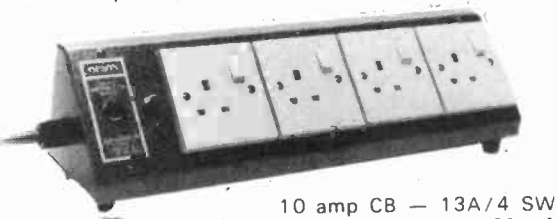

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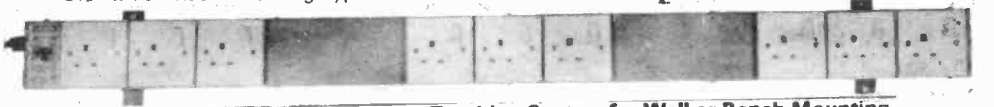

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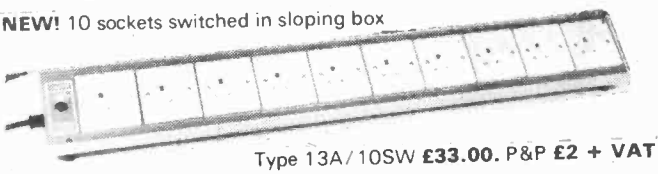

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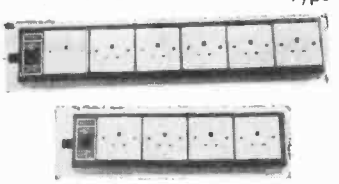

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2.2/25 R	.028	47/63 R	.045
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4.7/10 R	.022	100/35 R PC	.035
4.7/25R	.028	220/16 A	.055
4.7/50 R	.034	220/25 R	.065
10/16 R	.030	220/70 A	.075
10/25 R	.032	330/50 A	.075
10/25 R PC	.022	330/100 A	.085
10/25 A	.035	470/16 R	.080
10/50 A	.040	470/100 RC	.150
10/100 R	.042	1000/40 A	.230
15/40 A	.030	1000/63 A	.280
22/10 R	.021	2200/10 A	.080
22/25 A	.025	2200/25 A	.280
22/25 R	.027	2200/40 RC	.350
22/63 A	.040	3300/10 A	.090
33/16 A	.022	3300/25 A	.180
47/6 A	.015	4700/10 A	.100
47/25 A	.032	4700/25 RC	.250
47/35 R	.038	4700/40 RC	.35
47/40 A	.045	10000/15 RC	.250

R = radial leads
A = axial leads
RC = tag ended can
R PC = short radial leads for PC mounting

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.01	400V	C296	.025
.015	250V	C280	.025
.022	400V	C280	.025
.068	250V	Advance	.025
.22	250V	C280	.035
.22	250V	Advance	.035
.22	100V	Minibox	.035
.47	250V	C280	.05
.47	160V	C296	.04
1.0	250V	C280	.055
1.5	63V	Filmcap	.065
2.2	160V	Filmcap	.095
3.3	100V	Wima MKS	.15
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4.7	100V	Wima MKS	.235
6.8	100V	Wima MKS	.285

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3mm red	.055	5mm yellow	.09
3mm yellow	.08	5mm green	.09
3mm green	.08	3mm clips	.02
5mm red	.06	5mm clips	.02

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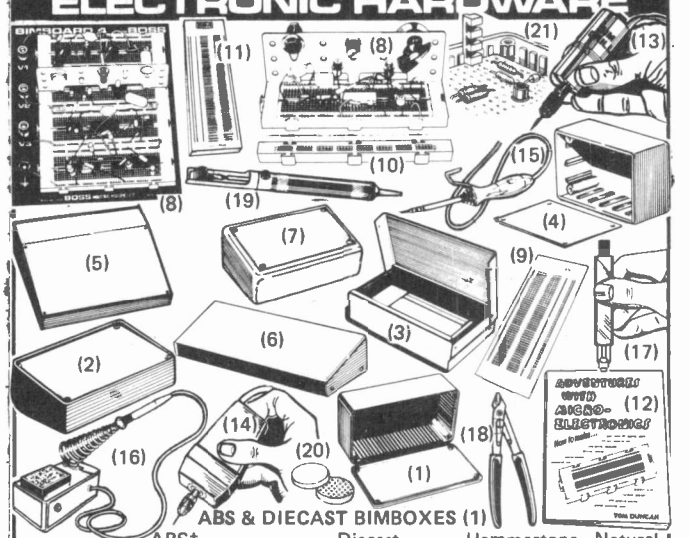

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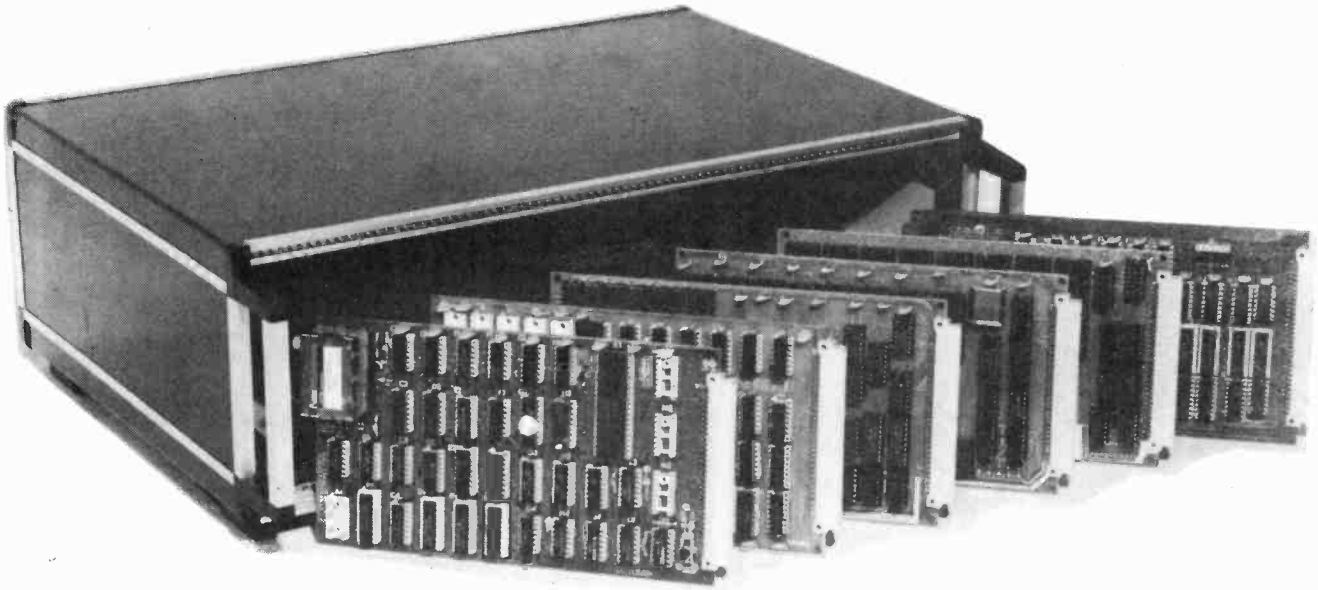

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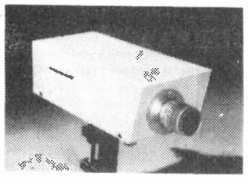

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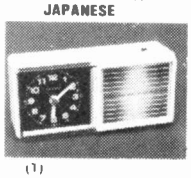

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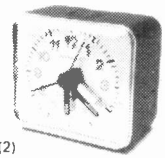

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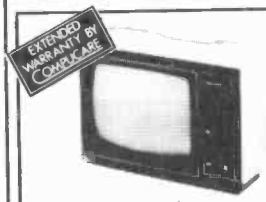

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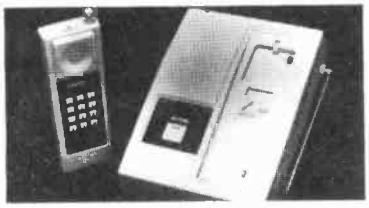

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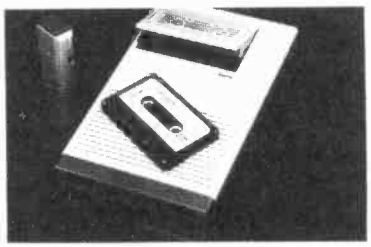

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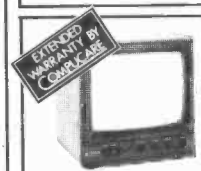

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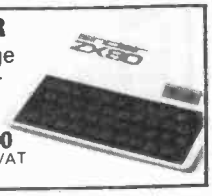

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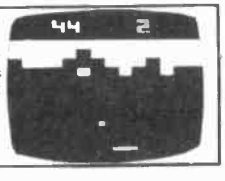

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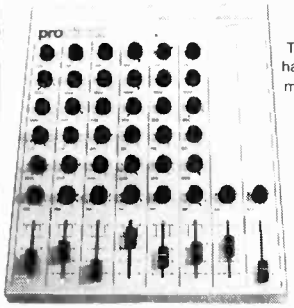

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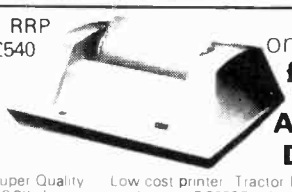

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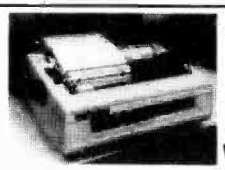

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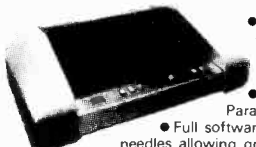

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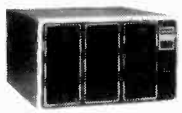

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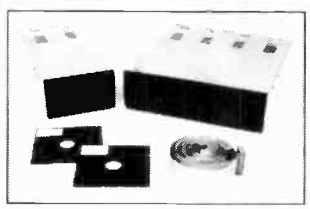

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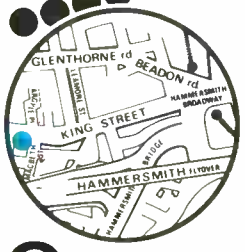

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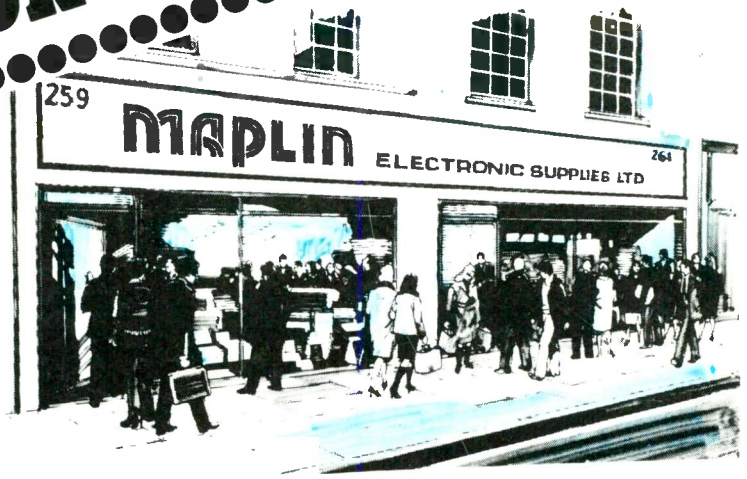

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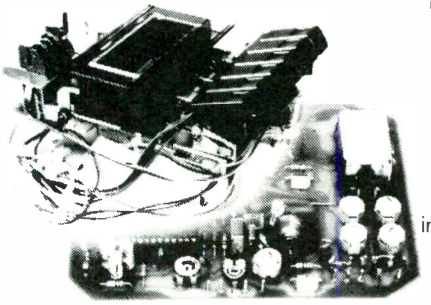

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